PROFESSIONAL COMPONENTS

DATA HANDBOOK

High-power klystrons
and accessories

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Philips Components

PHILIPS

HIGH-POWER KLYSTRONS AND ACCESSORIES

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SELECTION GUIDE

UHF POWER KLYSTRONS

type	status	cooling	output power, peak sync. kW	frequency range MHz
YK1001	M	FA	11	470 to 860
YK1002	M	W, FA	11	470 to 860
YK1151	M	FA	25	470 to 860
YK1190	M	V/VC/W	45	470 to 610
YK1191	M	V/VC/W	45	590 to 720
YK1192	M	V/VC/W	45	710 to 860
YK1198	M	V/VC/W, FA	60 CW	600 to 800
YK1220	C	V/VC/W, FA	16.5	470 to 860
YK1221	N	V/VC/W, FA	7.5	470 to 860
YK1223	P	V/VC/W, FA	16,5	470 to 860
YK1230	C	V/VC/W, FA	27	470 to 860
YK1233	P	V/VC/W, FA	27	470 to 860
YK1234	N	V/VC/W, FA	30	470 to 860
YK1235	N	V/VC/W, FA	30	470 to 860
YK1263	P	V/VC/W, FA	58	470 to 810
YK1265	P	V/VC/W, FA	64	470 to 860
YK1267	N	V/VC/W, FA	70	470 to 860
YK1270	N	FA	15	470 to 860
YK1273	N	FA	15	470 to 860
YK1290	C	V/VC/W	45	470 to 610
YK1291	C	V/VC/W	45	590 to 720
YK1292	C	V/VC/W	45	710 to 860
YK1295	C	V/VC/W, FA	58	470 to 610
YK1296	C	V/VC/W, FA	58	590 to 720
YK1297	C	V/VC/W, FA	58	710 to 860

HIGH POWER KLYSTRONS

type	status	cooling	output power CW kW	output power pulse kW	centre frequency MHz
YK1240	P	W	—	330	1300
YK1250	P	W	400	—	999.3
YK1300	M	W	600	—	499.7
YK1301	P	W	800	—	499.7
YK1302	C	V, FA	800	—	508.6
YK1303	P	V, FA	1000	—	508.6
YK1305	P	W	350	—	499.7
YK1350	P	W	1000	—	352.21

COOLING: FA = forced air; W = water; V = vapour; VC = vapour condensation.

PULSED POWER KLYSTRONS

type	status	cooling	output power kW	gain dB	frequency MHz
YK1110	C	W	6000	30	2998 ± 5
YK1510	P	W	20000	44	S-band
YK1511	P	W	20000	44	S-band
YK1512	P	W	20000	44	S-band
YK1600	N	W	35000	53	2998.5

COOLING: FA = forced air; W = water; V = vapour; VC = vapour condensation.

CLASSIFICATION

The devices are classified as follows:

N = **New type.** Recommended for new equipment design. Data sheets contain advance information and specifications are subject to change without notice.

P = **Prefered type.** Recommended for equipment design; production quantities available at date of publication.

C = **Current type.** No longer recommended for equipment design; available for equipment production and for use in existing equipment.

M = **Maintenance type.** No longer recommended for equipment production; available for maintenance of existing equipment.

O = **Obsolescent type.** Available until present stocks are exhausted.

Obsolescent types of which all stocks are exhausted are called **obsolete** ; any data still published on these types is for reference purposes only.

GENERAL

LIST OF SYMBOLS

1. Symbols denoting electrodes and electrode connections

Anode	a
Accelerator electrode	acc
Collector electrode	coll
Filament or heater	f
Filament or heater tap	f_c
Grid	g
Tube pin which must not be connected externally	i.c.
Cathode	k
Resonator	res
Helical electrode	x

2. Symbols denoting voltages

Remarks

a. In the case of indirectly heated tubes the voltages on the various electrodes are with respect to the cathode; in the case of directly heated, AC fed tubes, with respect to the negative side of the filament; and in the case of directly heated, AC fed tubes, with respect to the electrical centre of the filament, unless otherwise stated.

b. The symbols quoted below represent the average values of the voltages concerned, unless otherwise stated.

Anode voltage	V_a
Anode voltage in cut-off or in cold condition	V_{ao}
Accelerator voltage	V_{acc}
Supply voltage of tube electrodes	V_b
Collector voltage	V_{coll}
Filament or heater voltage	V_f
Filament or heater starting voltage	V_{fo}
Voltage between focusing electrode and cathode	V_{foc}
Grid voltage	V_g
AC input voltage	V_i
Inverse voltage	V_{inv}
Voltage between cathode and heater	V_{kf}
AC output voltage	V_o
Peak value of a voltage	V_p
Resonator voltage	V_{res}
Voltage on helical electrode	V_x

3. Symbols denoting currents

Remarks

a. The positive electrical current is directed opposite to the direction of the electron current.

b. The symbols quoted below represent the average values of the currents concerned, unless otherwise stated.

Anode current	I_a
Accelerator current	I_{acc}
Collector current	I_{coll}
Filament or heater current	I_f
Filament or heater starting current	I_{fo}
Peak filament or heater starting current	I_{fp}, I_{fsurge}
Grid current	I_g
Cathode current	I_k
Peak value of a current	I_p
Resonator current	I_{res}
Current to helical electrode	I_x

4. Symbols denoting powers

Anode dissipation	W_a
Collector dissipation	W_{coll}
AC driving power	W_{dr}
~~Grid dissipation~~	W_g
Input power	W_i
DC anode supply power	W_{ia}
Peak input power	W_{ip}
Output power	W_o
Peak output power	W_{op}
Resonator dissipation	W_{res}

5. Symbols denoting capacitances

Measured on the cold tubes.

Capacitance between anode and all other elements except control grid	C_a
Capacitance between anode and grid (all other elements being earthed)	C_{ag}
Capacitance between anode and cathode (all other elements being earthed)	C_{ak}
Capacitance between a grid and all other elements except anode	C_g
Capacitance between a grid and cathode (all other elements being earthed)	C_{gk}

6. Symbols denoting resistances

External AC resistance in anode lead or matching resistance	R_a
Filament or heater resistance in cold condition	R_{fo}
External resistance in a grid lead	R_g
Internal resistance of a tube	R_i
External resistance in a cathode lead	R_k
External resistance between cathode and heater	R_{kf}

7. Symbols denoting various quantities

Bandwidth	B
Noise factor	F
Frequency	f
Pulse repetition rate	f_{imp}
Power gain	
Magnetic field strength	H
Height above sea level	h
Pressure drop of cooling air or cooling water	Δp
Required air flow or water flow for cooling	q
Transconductance	S
Temperature of anode or anode block	T_a
Ambient temperature	T_{amb}
Averaging time of current or voltage	t_{av}
Inlet temperature of cooling air or cooling water	T_i
Pulse duration	t_{imp}
Outlet temperature of cooling air or cooling water	T_o
Time of rise of voltage	t_{rv}
Cathode preheating time, also called waiting time; the minimum period of time during which the heater or filament voltage should be applied before the application of electrode voltages	t_w
Rate of rise of voltage	$\frac{dV_a}{dt}$, $\frac{\Delta V}{\Delta t_{rv}}$
Voltage standing-wave ratio	VSWR
Reflection coefficient	σ
Duty factor	δ
Efficiency	η
Wavelength	λ
Amplification factor	μ
Temperature, relative	θ

TUBES FOR MICROWAVE EQUIPMENT
DEFINITIONS

B	Bandwidth.
$\Delta f/\Delta T$	The temperature coefficient $\Delta f/\Delta T$ is the change of frequency with temperature.
f_{imp}	Pulse repetition rate.
Δf_p	The pulling figure Δf_p is the difference between the maximum and minimum frequencies, reached when the phase angle of the load with a VSWR of 1,5 is varied from 0^o to 360^o.
H	Magnetic field strength.
t_{imp}	The pulse duration t_{imp} is defined as the time interval between the two points on the current pulse at which the current is 70% of the smooth peak current (see Fig.1).

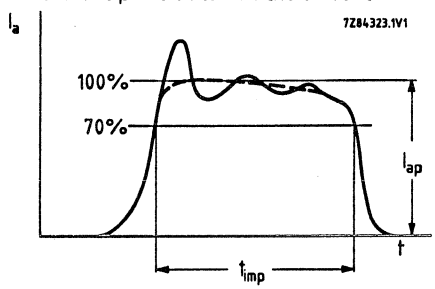


Fig. 1 Current pulse.

The smooth peak is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse.

t_{rv}	The time of rise of voltage t_{rv} is defined as the time interval between points of 10 and 90 per cent of the smooth peak value measured on the leading edge of the voltage pulse.
T_a	Temperature of anode or anode block.
VSWR	The voltage standing-wave ratio in a waveguide is the ratio of the amplitude in the electrical field at a voltage maximum to that at an adjacent minimum.
dV_a/dt or $\Delta V_a/\Delta t_{rv}$	Unless otherwise stated the rate of rise of voltage dV_a/dt is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value (see Fig. 2).

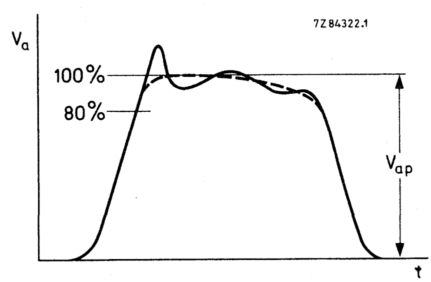


Fig. 2 Voltage pulse.

δ	The duty factor δ is the ratio of the pulse duration to the time between corresponding points of two successive pulses.

RECTANGULAR WAVEGUIDE DATA AND DESIGNATIONS

FREQUENCY RANGE TE_{10} - mode 153-IEC* GHz	WAVEGUIDE DESIGNATION 153-IEC*	BRITISH STAND.	RETMA	JAN RG- /U brass	JAN RG- /U alum.	BAND PREFIX	WAVEGUIDE Inner cross-section 153-IEC* Width mm	Height mm	Tolerance on width and height ±	WAVEGUIDE Outer cross-section 153-IEC* Width mm	Height mm	Tolerance on width and height ±	ATTENUATION in dB/m for copper waveguide 153-IEC* Frequency GHz	Theoretical value	Maximum value	Theoretical C. W. power rating** lowest to highest frequency MW
1.14 — 1.73	R 14	WG 6	WR 650	69	103	L	165.10	82.55	0.33	169.16	86.61	0.20	1.36	0.00522	0.007	12.0 — 17.0
1.45 — 2.20	R 18	WG 7	WR 510	—	—	D	129.54	64.77	0.26	133.60	68.83	0.20	1.74	0.00749	0.010	7.5 — 11.0
1.72 — 2.61	R 22	WG 8	WR 430	104	105	—	109.22	54.61	0.22	113.28	58.67	0.20	2.06	0.00970	0.013	5.2 — 7.5
2.17 — 3.30	R 26	WG 9A	WR 340	112	113	—	86.36	43.18	0.17	90.42	47.24	0.17	2.61	0.0138	0.018	3.4 — 4.8
2.60 — 3.95	R 32	WG 10	WR 284	48	75	S	72.14	34.04	0.14	76.20	38.10	0.14	3.12	0.0189	0.025	2.2 — 3.2
3.22 — 4.90	R 40	WG 11A	WR 229	—	—	A	58.17	29.083	0.12	61.42	32.33	0.12	3.87	0.0249	0.032	1.6 — 2.2
3.94 — 5.99	R 48	WG 12	WR 187	49	95	G	47.55	22.149	0.095	50.80	25.40	0.095	4.73	0.0355	0.046	0.94 — 1.32
4.64 — 7.05	R 58	WG 13	WR 159	—	—	C	40.39	20.193	0.081	43.64	23.44	0.081	5.57	0.0431	0.056	0.79 — 1.0
5.38 — 8.17	R 70	WG 14	WR 137	50	106	J	34.85	15.799	0.070	38.10	19.05	0.070	6.46	0.0576	0.075	0.56 — 0.71
6.57 — 9.99	R 84	WG 15	WR 112	51	68	H	28.499	12.624	0.057	31.75	15.88	0.057	7.89	0.0794	0.103	0.35 — 0.46
7.00 — 11.00	—	—	WR 102	—	320	T	25.90	12.95	0.125	29.16	16.21	0.125	—	—	—	0.33 — 0.43
8.2 — 12.5	R 100	WG 16	WR 90	52	67	X	22.860	10.160	0.046	25.40	12.70	0.05	9.84	0.110	0.143	0.20 — 0.29
9.84 — 15.0	R 120	WG 17	WR 75	—	—	M	19.050	9.525	0.038	21.59	12.06	0.05	11.8	0.133	—	0.17 — 0.23
11.9 — 18.0	R 140	WG 18	WR 62	91	—	P	15.799	7.899	0.031	17.83	9.93	0.05	14.2	0.176	—	0.12 — 0.16
14.5 — 22.0	R 180	WG 19	WR 51	—	—	—	12.954	6.477	0.026	14.99	8.51	0.05	17.4	0.238	—	0.080 — 0.107
17.6 — 26.7	R 220	WG 20	WR 42	53	121	—	10.668	4.318	0.020	12.70	6.35	0.05	21.1	0.370	—	0.043 — 0.058
21.7 — 33.0	R 260	WG 21	WR 34	—	—	—	8.636	4.318	0.020	10.67	6.35	0.05	26.1	0.435	—	0.034 — 0.048
26.4 — 40.0	R 320	WG 22	WR 28	—	—	—	7.112	3.556	0.020	9.14	5.59	0.05	31.6	0.583	—	0.022 — 0.031
32.9 — 50.1	R 400	WG 23	WR 22	—	—	—	5.690	2.845	0.020	7.72	4.88	0.05	39.5	0.815	—	0.014 — 0.020
39.2 — 59.6	R 500	WG 24	WR 19	—	—	—	4.775	2.388	0.020	6.81	4.42	0.05	47.1	1.060	—	0.011 — 0.015
49.8 — 75.8	R 620	WG 25	WR 15	—	—	—	3.759	1.880	0.020	5.79	3.91	0.05	59.9	1.52	—	0.0063 — 0.0090
60.5 — 91.9	R 740	WG 26	WR 12	—	—	—	3.099	1.549	0.020	5.13	3.58	0.05	72.6	2.03	—	0.0042 — 0.0060
73.8 — 112.0	R 900	WG 27	WR 10	—	—	—	2.540	1.270	0.020	4.57	3.30	0.05	88.6	2.74	—	0.0030 — 0.0041
92.2 — 140.0	R 1200	WG 28	WR 8	—	—	—	2.032	1.016	0.020	4.06	3.05	0.05	111.0	3.82	—	0.0018 — 0.0026
114.0 — 173.0	R 1400	WG 29	WR 7	—	—	—	1.651	0.826	—	—	—	—	136.3	5.21	—	0.0012 — 0.0017

* IEC Recommendations are obtainable from :
Central Office of the International Electrotechnical Commission
1, rue de Varembé
GENEVA, Switzerland

** based on breakdown of air of 15,000 volts per cm (safety factor of approx. 2 at sea level)

FLANGE DESIGNATIONS

FOR WAVEGUIDE 153 - IEC*	FLANGE DESIGNATION: PLAIN FLANGE 154 - IEC	PLAIN FLANGE JAN UG /U Brass	PLAIN FLANGE JAN UG /U Aluminium	CHOKE FLANGE 154 - IEC	CHOKE FLANGE JAN UG /U Brass	CHOKE FLANGE JAN UG /U Aluminium
R 14	PDR 14	417A	418A			
R 18	PDR 18					
R 22	PDR 22	435A	437A			
R 26	PDR 26	553	554			
R 32	UER 32 PDR 32 PAR 32 UAR 32	53	584	CAR 32	54A	585A
R 40	UER 40 PDR 40					
R 48	PAR 48 PDR 48 UAR 48 UER 48	149A	407	CAR 48	148C	406B
R 58	PAR 58 PDR 58 UAR 58 UER 58			CAR 58		
R 70	PAR 70 PDR 70 UAR 70 UER 70	344	441	CAR 70	343B	440B
R 84	PBR 84 PDR 84 UBR 84 UER 84	51	138	CBR 84	52B	137B
R 100	PBR 100 PDR 100 UBR 100 UER 100	39	135	CBR 100	40B	136B
R 120						
R 140	PBR 140 UBR 140	419		CBR 140	541A	
R 180						
R 220	PBR 220 UBR 220 PCR 220	595	597	CBR 220	596A	598A
R 260	PCR 260					
R 320	PBR 320 PCR 320 UBR 320	599		CBR 320	600A	
R 400	PCR 400	383				
R 500	PCR 500 PAR 500					
R 620	PCR 620 PFR 620	385				
R 740	PCR 740 PFR 740	387				
R 900	PCR 900 PFR 900					
R 1200	PCR1200 PFR 1200					

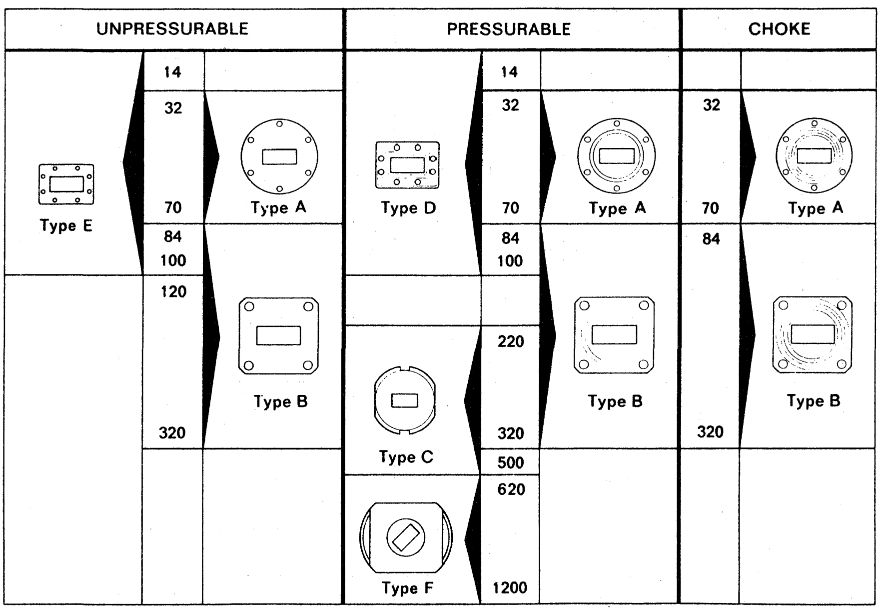
IEC

Waveguide flanges covered by IEC recommendation shall be indicated by a reference number comprising the following information:

a. the number of the present IEC publication.
b. the letter "IEC".
c. a dash.
d. a letter relating to the basic construction of the flange

P = pressurable
C = choke, pressurizable
U = unpressurizable

e. a letter for the type according to the drawing. Flanges with the same letter and of the same waveguide size can be mated.
f. the letter and number of the waveguide for which the flange is designed.



* IEC Recommendations are obtainable from :

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International Electrotechnical Commission
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GENERAL OPERATIONAL RECOMMENDATIONS KLYSTRONS

1. GENERAL

1.1 Data

The characteristic data, operational data, capacitance values and curves apply to an average tube which is characteristic of the type of tube in question.

1.2 Reference point of the electrode voltages

If not otherwise stated the electrode voltages are given with respect to the cathode.

1.3 Operational data

The operational data stated in the data sheets do not relate to any fixed setting instructions. They should rather be regarded as recommendations for the effective use of the tube. On account of the tolerances prevailing, deviations from the settings stated may occur.

It is also possible to use other settings, for which purpose the graphs can be used for finding the operational data, or which purpose interpolation between the settings stated can be performed. If one wishes to deviate from the settings recommended in the data sheets, one should take great care not to exceed the permissible limiting values. If appreciable deviations occur, the manufacturer should be consulted.

A general rule for multi-cavity klystrons is that the accelerator electrode voltage and/or the focusing electrode voltage must be adjusted so that the cathode current stated will flow.

1.4 DC connections

At all times there should be a DC connection between each electrode and the cathode. If necessary, limiting values have been stated for the resistance of these connections.

1.5 Mounting and removal

The instructions relating to each type of tube can be found in the data sheets and the "Instructions for operation and maintenance".

The mounting and removal should be effected with extreme care to avoid damage to the tube. This also applies to rejected tubes, where claims are made under guarantee.

Ferromagnetic parts must not be used in the vicinity of klystrons equipped with a permanent magnet, as this might have a detrimental effect on the operation of the klystron.

If necessary, the ceramic insulators and windows must be carefully cleaned, as dirt may damage the klystron on account of local overheating. Naturally the flange of the output cavity must also be thoroughly cleaned so as to prevent arcing.

The "Instructions for operation and maintenance" should in all cases be followed.

1.6 Accessories

Perfect operation of the tubes can only be guaranteed if use is made of the accessories which the manufacturer designed for the tube.

1.7 Supply leads

The supply leads to the connections and terminals must be of such a quality that no mechanical stresses, due to differences in temperature or other causes, can occur.

1.8 Danger of radiation

In general the absorption in the tissues of the body, and hence the danger, is the greater the shorter the wavelength of the RF radiation for equal output. The output of klystrons may be so high that injuries (in particular of the eye) can be inflicted.

Klystrons operated at a high voltage (exceeding 16 kV) may, moreover, emit X-rays of appreciable intensity, which call for protection of the operators.

2. LIMITING VALUES

2.1 Absolute limiting values

In all cases the limiting values stated are absolute maximum or minimum values. They apply either to all settings or to the various modes of operation. The values stated should in no case be exceeded, neither on account of mains voltage fluctuations and load variations, nor on account of production tolerances in the various building elements (resistors, capacitors, etc.) and tubes, or as a result of meter tolerances when setting the voltages and currents.

Every limiting value should be regarded as the permissible absolute maximum independent of other values. It is not permitted to exceed one limiting value because another is not reached. For instance, one should not allow the limiting value of the collector current to be surpassed while reducing the collector voltage below the permissible limiting value. If in special cases it should be necessary to exceed a specific limiting value, it is advisable to consult the tube manufacturer, as otherwise no claims can be made.

2.2 Protective circuit

To prevent the limiting values of voltages, currents, outputs and temperatures from being exceeded, fast-operating protective circuits must be provided.

2.3 Drift current

The limiting value indicated for the drift current is an arithmetical mean value.

3. NOTES ON OPERATION

3.1 Operational data and variations

When developing electrical equipment the spread in the tube data must be taken into account; if necessary, the tube tolerances can be applied for.

With respect to the spread in the operational data and the average values stated in the data sheets it is recommended that a certain margin be allowed for in the output and input powers when designing equipment intended for series production.

3.2 Input power, required driving power

In the data sheets the power stated in the input power W_{dr} fed to the input cavity and measured between the circulator and this cavity with a 50 Ω resistor serving as a substitute for the load presented by the cavity.

3.3 Output power

As a general principle the effective output power is stated.

3.4 Sequence of application of the electrode voltages

With multy-cavity klystrons the electrode voltages must be connected in the order given in the operating instructions.

3.5 Drift current

When the klystron is driven by an AM signal (for instance a video signal), the drift current fluctuates with the modulation. Consequently, the power supply unit must be designed so as to be suitable for the peak values occurring, which may be appreciably higher than the arithmetical mean values stated.

4. HEATING

4.1 Type of current

Klystrons can be heated by means of either standard alternating current or direct current. At other frequencies the tube manufacturer should be consulted.

4.2 Adjusting the heater voltage

The heater voltage generally governs the adjustment of the heating, while the heater current may deviate from the nominal value within fixed tolerances. The heater voltage should be maintained as accurately as possible. For measuring the heater voltage a RMS. voltmeter is required. This meter must be directly connected to the filament terminals of the tube and have an inaccuracy < 1.5 % in the voltage range concerned. The indicated measuring value should lie in the uppermost third of the scale.

4.3 Switching on the heater current

If the data sheet does not contain special data concerning the heater current during switching-on, the tube may be switched on at full heater voltage.

If maximum values are stated for the heater current during switching-on, they relate to the absolute maximum instantaneous value under unfavorable conditions. In the case of a AC supply this value will occur if the tube is switched on at the maximum amplitude of the highest mains voltage. It is possible to calculate the maximum current during switching-on if the cold resistance and the relationship between the heater current and the heater voltage is known. In practice a heater transformer more or less acting connected in series with the primary of the heater transformer. The choke coil or resistor can be short-circuited by a relay whose action is delayed by about 15 seconds. By means of a calibrated oscilloscope it can be checked whether the starting current remains within the permissible limits; the supply lead may, if necessary, be used as measuring resistance.

5. COOLING

5.1 Forced-air cooling

It is essential that the faces of tubes that are to be cooled by an air-blast should be hit as evenly as possible by the air stream, so as to prevent large differences in temperature which may give rise to mechanical stresses. In many cases (in particular with the large types of tubes) an additional air stream must be directed to the metal-to-ceramic seals. The cooling air is usually supplied from a fan via an insulating duct. This air should be filtered, so that all impurities and moisture are removed; in addition to this the radiator must be cleaned at regular intervals. The data concerning the cooling can be found in the data sheets. The cooling must be switched on together with the heating. After the klystron has been switched off cooling air must be supplied for some time; this period depends on the size of the tube and the load. If the cooling of whatever part of the tube is interrupted or if the quantity of cooling air is too small, the collector voltage and the heating must be switched off automatically.

5.2 Water cooling

With water-cooled klystrons the cooling equipment is rigidly attached to the tube. If the equipment should be live, the cooling water must be supplied through insulating pipes, of sufficient length.

The water cooling and air cooling for other parts of the tube must be switched on together with the heating. The cooling-water circuit must be arranged so that the water always enters at the bottom, no matter how the tube is mounted. If the pumps should be out of operation, the water jacket(s) of the tube must always be full. In that case after-cooling may in general be done away with.

In many cases the metal-to glass or metal-to-ceramic seals require additional cooling by a low-velocity air flow. If the cooling water supply or additional air cooling should fail, the collector voltage and heating must immediately be switched off. Further cooling data can be found in the data sheets.

The specific resistance of the cooling water must be minimum 20 kΩ·cm, the temporary hardness must be maximum 6 German degrees of hardness. In principle distilled water should be used in circulation cooler; to reduce the corrosive effect of the distilled water about 700 mg of 24% hydrazine hydrate and 700 mg sodium silicate (water glass) must be added per litre. The pH-value should range from 7 to 9.

If frost is to be expected, a standard glycol based antifreeze for cars, like Glysantin should be added.

5.3 Vapour cooling

The conversion of water of 100 °C to steam of 100 °C requires an energy of 2256 kJ/l. This energy is extracted from the collector which by this means is cooled very effectively.

The cooling system may be designed as a closed circuit where the steam is ducted upwards or downwards to the applied heat exchanger. Due to a strong deposit of minerals during the continued variation of the aggregate state, the use of distilled water is absolutely necessary. When commencing operation a multiple change of the complete cooling water is recommended to dispose deteriorations of the systems.

The loss of coolant during operation is very low (1 litre per week approx.).

It is obvious, that a vapour cooling system is advantageous only in stationary assemblies and for high dissipation levels. This, however, yields another advantage of vapour cooling. The energy, generated in the heat exchanger, can be used very effectively i. e. for heating purposes.

6. STORAGE

Klystrons may only be stored in their original packing and according to the instructions, so as to avoid damage. For fitting, the tubes must be removed from the packing and directly inserted into the support. In all cases the "Instructions for operation and maintenance" must be adhered to.

In the case of prolonged storage the vacuum of high-power klystrons should be checked at intervals of about three month and improved if necessary, both being possible with the aid of the built-in ion-getter pump an a suitable power supply/test unit. During this operation the heater supply should preferably be turned on slowly.

RATING SYSTEM

(in accordance with IEC Publication 134)

ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

HIGH POWER KLYSTRONS

U.H.F. POWER KLYSTRONS

Power amplifier klystrons in metal-ceramic construction for the frequency band 470 MHz to 860 MHz designed for four external resonant cavities, beam focusing by means of permanent magnets, continuously operating getter-ion pump and operation with a depressed collector potential. These klystrons are intended for use as u.h.f. power amplifier in vision and/or sound transmitters for the TV bands IV and V.

QUICK REFERENCE DATA

Frequency range	470 to 860 MHz
Power output	11 kW
Power gain	30 dB

Cooling
- YK1001: air-cooled drift tubes and air-cooled collector
- YK1002: air-cooled drift tubes and water-cooled collector

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c. or d.c.

Cathode			dispenser type
Heater voltage	V_f		7.5 to 8.0 V

During operation the applied heater voltage should not fluctuate more than ± 3%. It is advised to operate the klystron at 8 to 8.5 V (including mains fluctuations) during the first 300 hours. The heater voltage should then be reduced to 7.5 to 8.0 V.

Heater current	I_f		32 (≤ 36) A

The heater current should never exceed a peak value of 80 A when applying an a.c. heater voltage or 65 A when applying a d.c. heater voltage.

Cold heater resistance	R_{fo}		28 mΩ
Waiting time	t_w	min.	180 s

GETTER-ION PUMP POWER SUPPLY

Pump voltage, unloaded (cathode reference)		4.0 kV
Internal resistance	approx.	300 kΩ

MECHANICAL DATA

Dimensions in mm

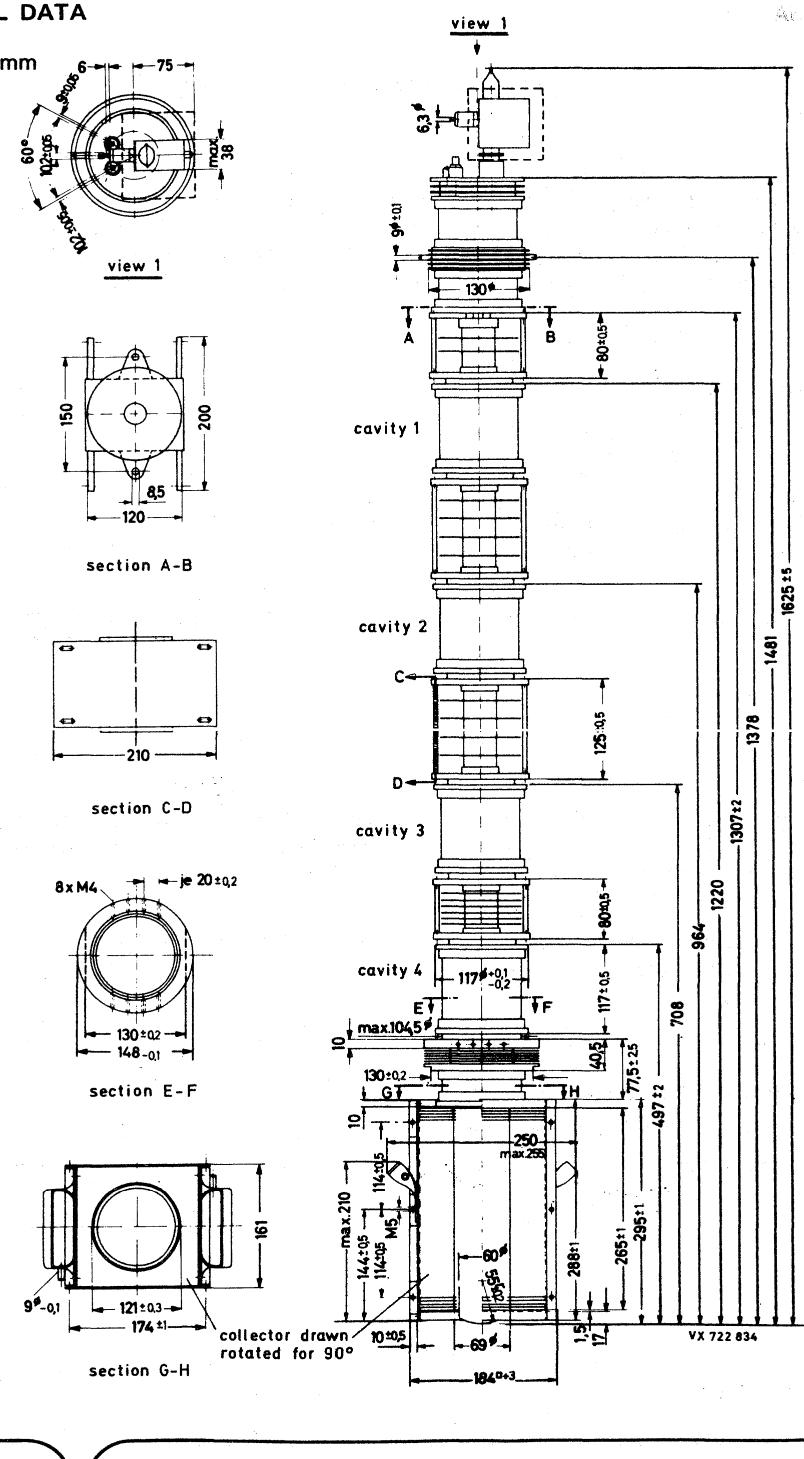


Fig. 1.

MECHANICAL DATA

Dimensions in mm

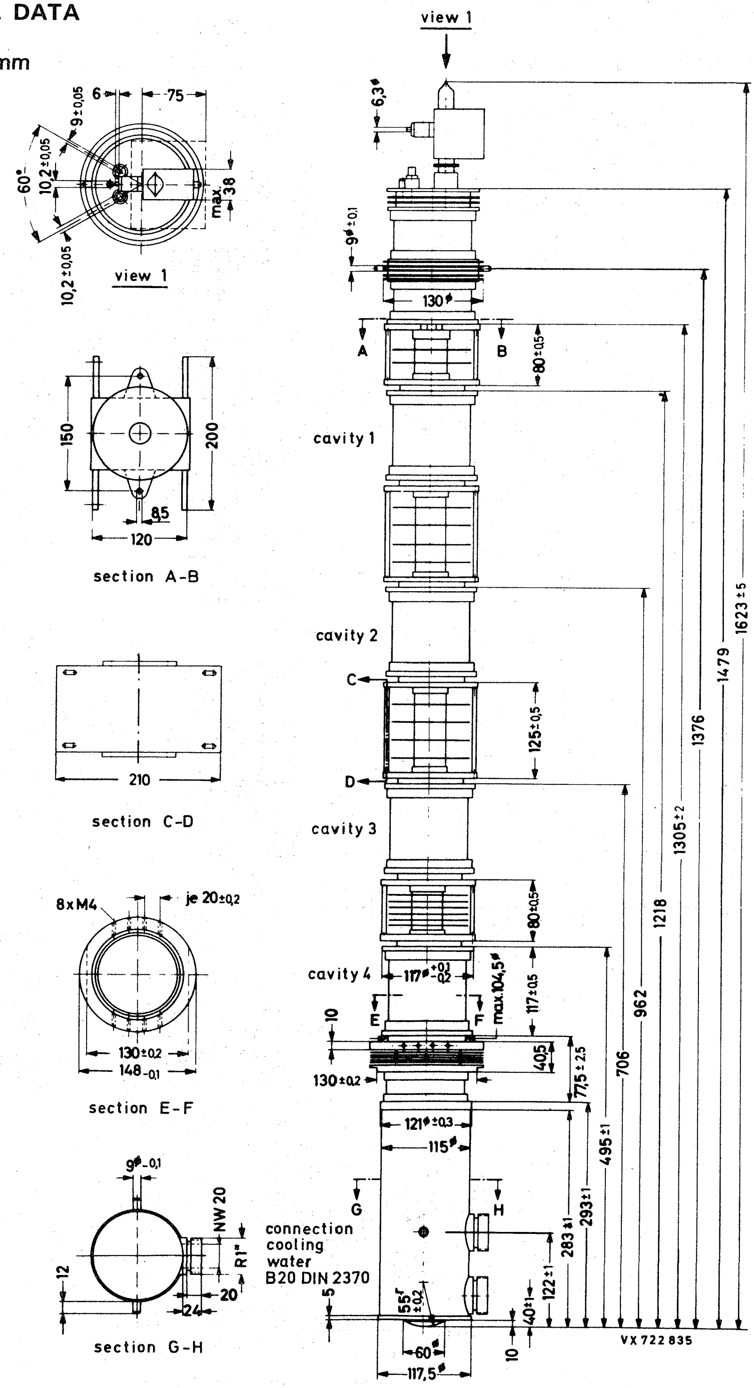


Fig. 2.

MECHANICAL DATA (continued)

Dimensions in mm

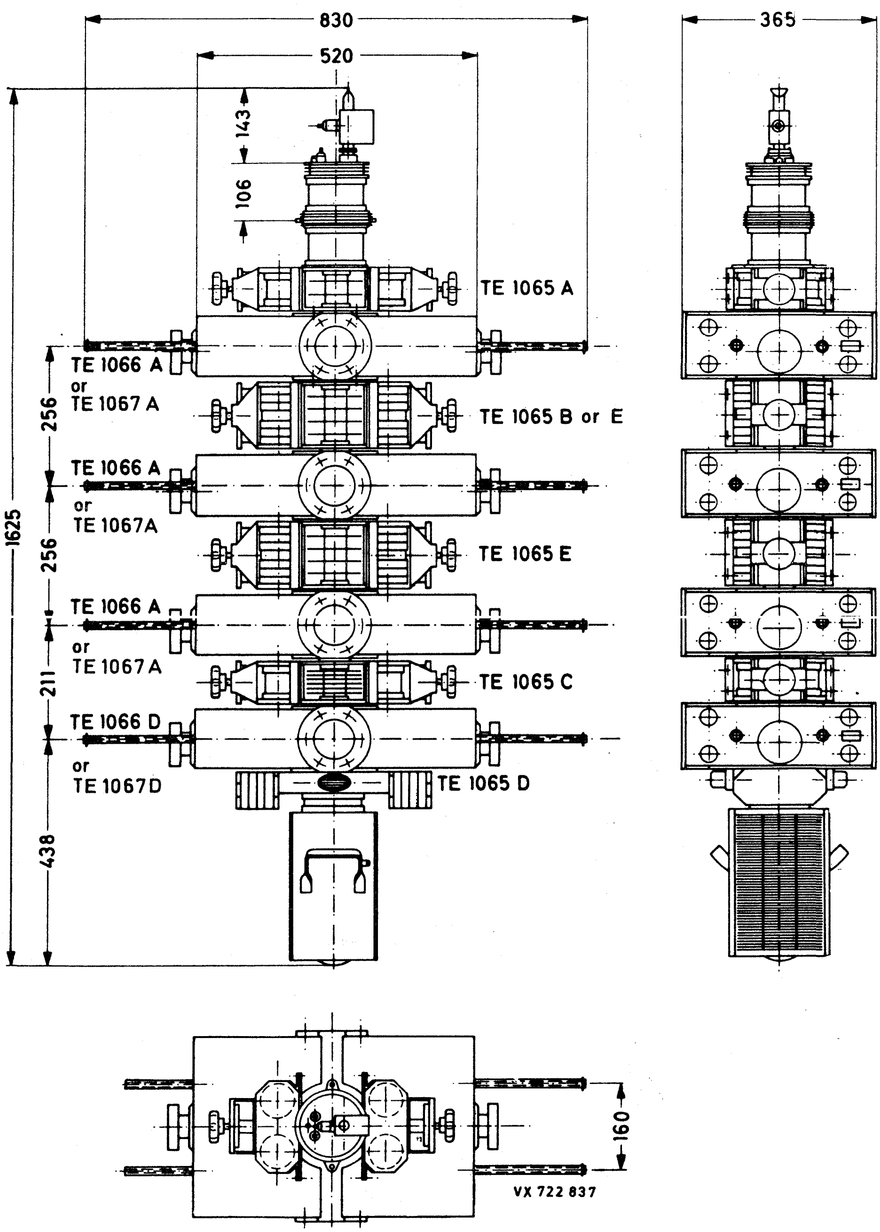


Fig. 3.

COOLING

Except collector, applicable up to an air-inlet temperature T_i of 40 °C and an altitude of 2500 m (values refer to air inlet).

Cathode base	air, q = approx. 0.5 m^3/min
Accelerating electrode	air, q = approx. 0.5 m^3/min
Drift tubes 1, 2 and 3	air, q = approx. 1.0 m^3/min each
Drift tube 4	air, q = approx. 1.5 m^3/min
Drift tube 5	forced air, q = approx. 1.5 m^3/min (Δp = 900 Pa = 9 mbar)
Cavity TE1066D or TE1067D	forced air, q = approx. 2.0 m^3/min (Δp = 900 Pa = 9 mbar)
Collector YK1001	forced air, see cooling curves Figs 5, 6 and 7
Collector YK1002	water, see cooling curves Figs 9 and 10

MOUNTING

Vertical, cathode up. In order to prevent distortion of the magnetic focusing field ferromagnetic material should not be used within a radius of 35 cm from the tube axis. All connections should be free from strain.

MASS (net)

YK1001	approx. 55 kg
YK1002	approx. 45 kg
Total mass of accessories	approx. 125 kg

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

ACCESSORIES

Heater connector	type 40649
Heater/cathode connector	type 40649
Focusing electrode connector	type 40634
Accelerating electrode connector	type 40634
Collector connector	type 40634
Getter ion pump connector	type 55351
Magnet unit for ion pump	type TE1053
Set of five pairs of focusing magnets	type TE1065 (2xA, 2xB, 2xC, 2xD, 2xE)*
Set of four cavities for 470 MHz to 790 MHz	type TE1066 (3xA, 1xD)
or	
Set of four cavities for 700 MHz to 860 MHz	type TE1067 (3xA, 1xD)
2 magnet field adaptor plates for collector (YK1001 only)**	type TE1073
Recommended circulators (optional)	
470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

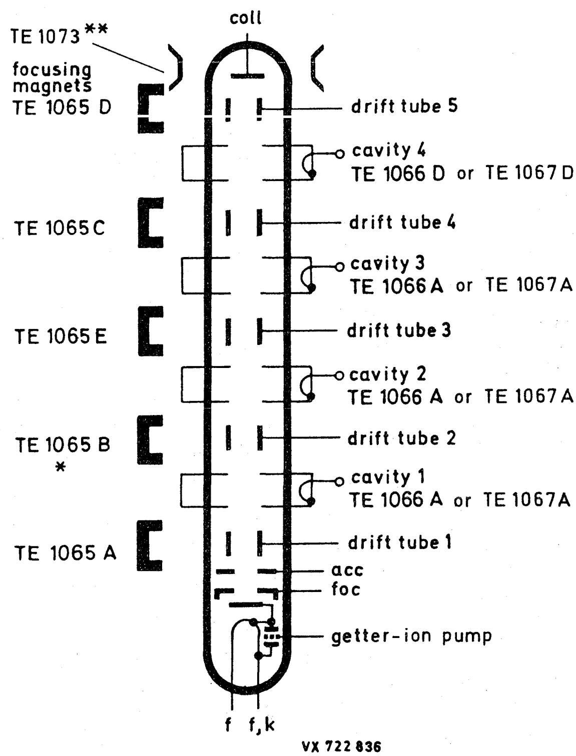


Fig. 4.

* If the klystron is used under TV transposer conditions replace 2xB by 2xE.

** Operation for vision and sound transmitter without depressed collector voltage.

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	8.5	V
Cathode voltage	max.	−22	kV
Cathode voltage at zero current	max.	−25	kV
Depressed collector voltage	max.	7	kV
	min.	0.5	kV
Cathode current	max.	2.3	A
Accelerating electrode voltage	max.	−25	kV
Series resistance in accelerating electrode circuit	max.	20	kΩ
	min.	10	kΩ
Negative focusing electrode voltage*	max.	700	V
	min.	100	V
Drift tube current**			
Collector dissipation	max.	40	kW
Load VSWR	max.	1.5	(14 dB)
Pump voltage	max.	4.5	kV
Pump current (see Fig. 8.)	max.	15	mA
Temperature of			
cathode base and accelerating electrode	max.	125	°C
drift tubes 1, 2 and 3	max.	80	°C
drift tubes 4 and 5	max.	150	°C
resonator 4	max.	125	°C
collector seal YK1001	max.	200	°C
Collector body YK1001▲	max.	300	°C
outlet cooling water YK1002	max.	75	°C
inlet cooling air	max.	40	°C

* The power supply must be preloaded with min. 10 mA at 500 V.

** For limiting values of various operating conditions see next page and Fig. 11.

▲ In safeguard this temperature limit the air outlet temperature should be measured in at least two places; one 50 mm and one 150 mm from the upper collector plate and 50 mm from the cooling fins; the cooling data of collector are minimum values.

MAXIMUM VALUES of drift tube current

For vision transmitter without level dependent cut-out threshold			
without depressed collector voltage	max.	80	mA
with depressed collector voltage	max.	130	mA
For vision transmitter with level dependent cut-out threshold			
without depressed collector voltage for 0 to 7 kW output power, peak sync.	max.	40	mA
with depressed collector voltage for 0 to 7 kW output power, peak sync.	max.	60	mA
without depressed collector voltage for full output power	max.	100	mA
with depressed collector voltage for full output power	max.	200	mA
For vision and sound transmitter fed from the same power supply and without level dependent cut-out threshold			
without depressed collector voltage	max.	100	mA
with depressed collector voltage	max.	160	mA
For vision and sound transmitter fed from the same power supply and with level dependent cut-out threshold			
without depressed collector voltage for 0 to 7 kW output power, peak sync.	max.	60	mA
with depressed collector voltage for 0 to 7 kW output power, peak sync.	max.	80	mA
without depressed collector voltage for full output power	max.	120	mA
with depressed collector voltage for full output power	max.	250	mA

TYPICAL OPERATING CONDITIONS

As 11 kW vision transmitter (CCIR-G standard)
in the frequency range 470 MHz to 790 MHz

notes 1, 2

		without depressed collector voltage	with depressed collector voltage		
Cathode voltage		−18.0	−13.5	kV	3
Depressed collector voltage		−0.5	−5.0	kV	
Accelerating electrode voltage		0	0	V	4
Neg. focusing voltage	≈	400	400	V	5
Drift tube current, static	≈	25	30	mA	
black level	≈	40	80	mA	6
Cathode current		1.9	1.9	A	
Output power, peak sync.		11	11	kW	
Drive power see Fig. 12.					
Linearity without compensation	≈	80	80	%	7
Sync. compression	⩽	45/25	45/25		8
V.S.B. suppression	⩽	−20	−20	dB	9
Noise with reference to black level	⩽	−46	−46	dB	10
Differential gain	≈	5	5	deg	11

As 2.2 kW and 4.4 kW TV sound amplifier

Cathode voltage		−18.0	−18.0	−13.5	−13.5	kV	3
Depressed collector voltage		−0.5	−0.5	−5.0	−5.0	kV	
Accelerating electrode voltage		−7.5	−5.5	−7.5	−5.5	kV	4
Neg. focusing voltage	≈	400	400	400	400	V	5
Drift tube current	≈	40	50	50	70	mA	6
Cathode current		0.7	1.0	0.7	1.0	A	
Output power		2.2	4.4	2.2	4.4	kW	
Drive power	⩽	0.5	0.5	0.5	0.5	W	

As 2.1 kW amplifier for television transposer service

Cathode voltage		−15	kV	3
Depressed collector voltage		5.0	kV	
Neg. focusing voltage	≈	400	V	5
Drift tube current	≈	60	mA	6
Cathode current		2.2	A	
Output power, peak sync.		2.1	kW	
Drive power see Fig. 12				
Intermodulation products	⩽	−51	dB	12

Notes

1. With the appropriate focusing magnets TE1065, cavities TE1066 and a circulator between the driver and input cavity.
   A precorrection of the level dependent frequency response up to 2 dB must be provided.
2. In case of failure the beam voltage must be switched off and made to drop below 5% of its nominal value within 500 ms of the failure.
3. Fluctuations of the beam voltage up to ± 3% will not damage the tube; to meet the signal-transfer quality requirements the nominal beam voltage should not vary more than ± 1%.
4. It is recommended that this voltage be obtained from a voltage divider between cathode and ground, which should carry a quiescent current of minimum 3 mA.
5. The focusing electrode voltage should be adjustable from 100 V to 500 V; a setting range from 100 V to 700 V is recommended.
6. At black level, to be focused for minimum drift tube current. If necessary to obtain the required signal-transfer quality, a deviation of maximum 10% from this minimum current is permitted. The limiting value, see Fig. 11, must however, not be exceeded.
7. Measured with a sawtooth voltage with amplitude between 17 and 75% of the peak sync value, on which is superimposed a 4.43 MHz sinewave with a 10% peak-to-peak value.
8. Calculated from $(1\text{-}V_{black}/V_{sync})_{in} / (1\text{-}V_{black}/V_{sync})_{out}$.
9. Measured with 10 to 75% modulation without compensation; V.S.B. filter between driving stage and klystron.
10. Produced by the klystron itself; without hum from power supplies.
11. Without compensation.
12. Without compensation, see German Bundespost 176 Pfl 2 or ARD-Pflichtenheft 5/2. Three-tone test method (vision carrier −8 dB, sound carrier −7 dB, sideband signal −16 dB with respect to peak sync = 0 dB).

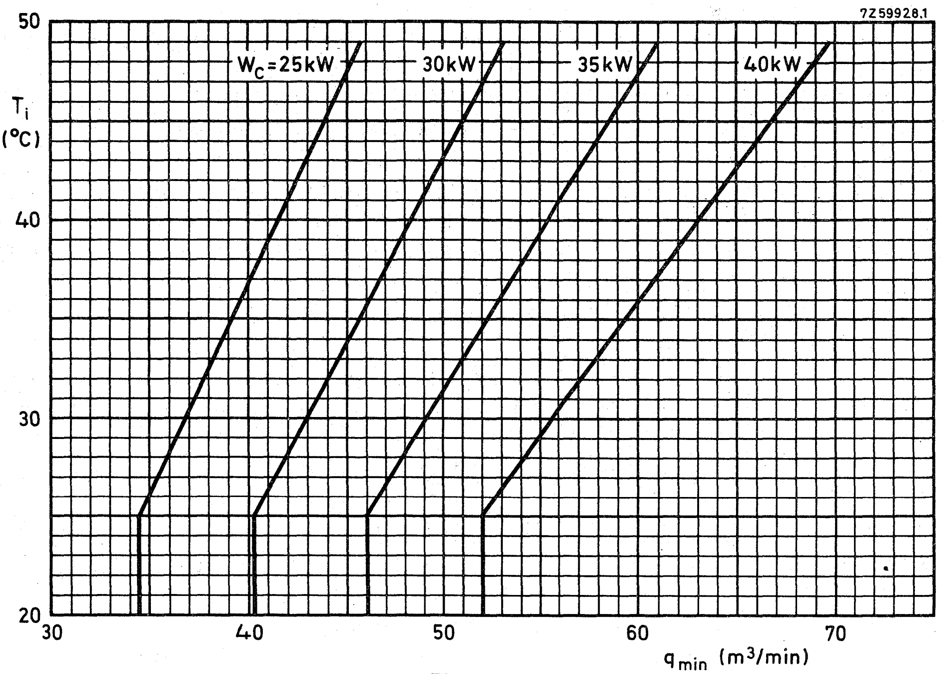

7Z59928.1
50
40
30
20
30
40
50
60
70
T_i (°C)
W_C = 25 kW
30 kW
35 kW
40 kW
q_{min} (m³/min)

Fig. 5.

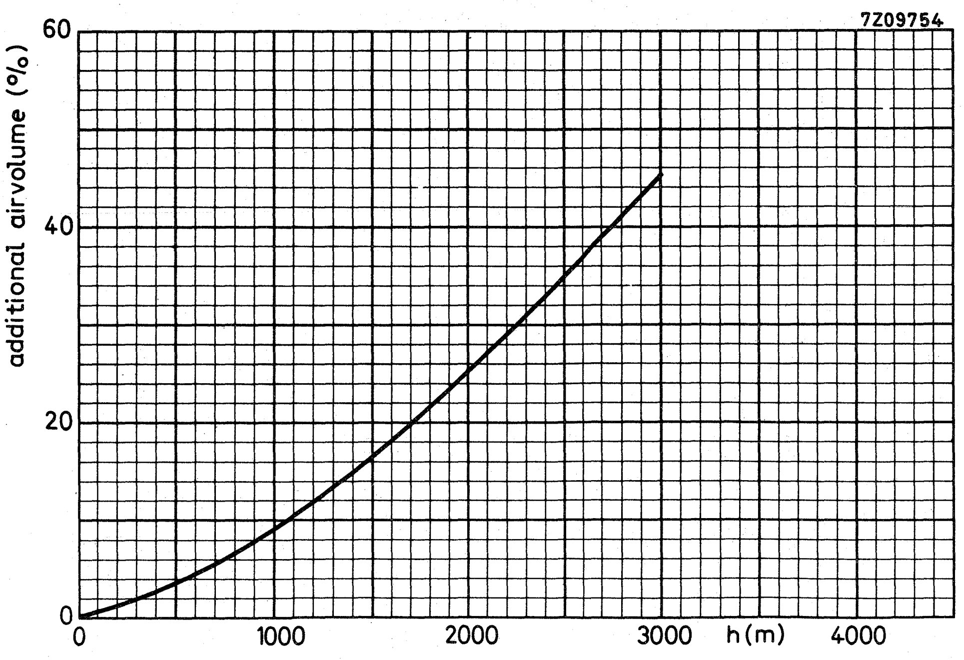

7Z09754
60
40
20
0
1000
2000
3000
4000
additional airvolume (%)
h (m)

Fig. 6.

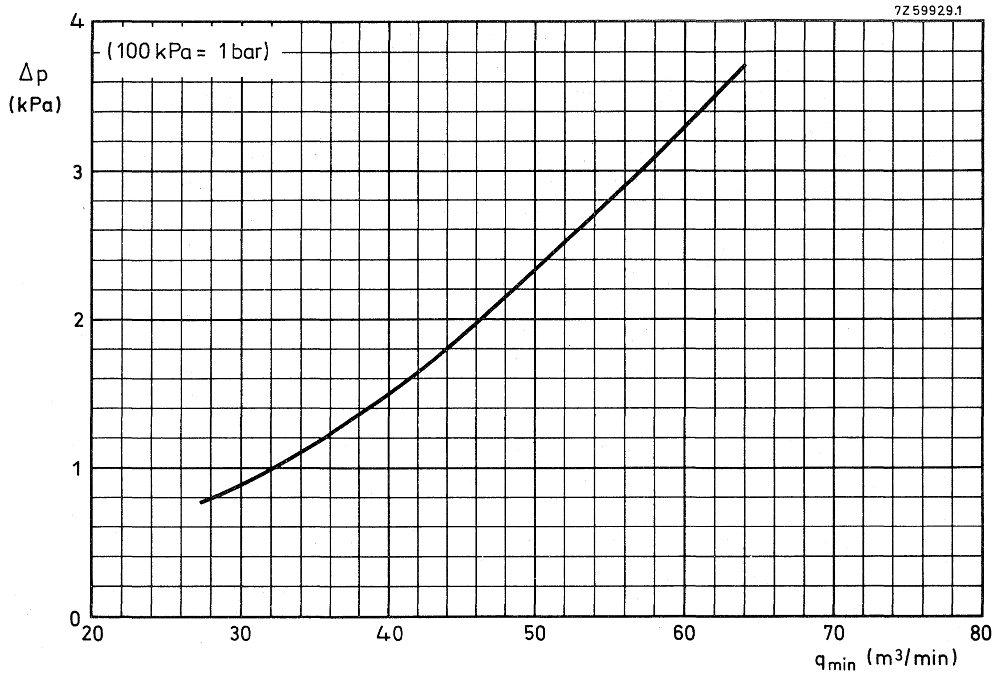


Fig. 7 Ratio of cooling air pressure to cooling air volume of YK1001.

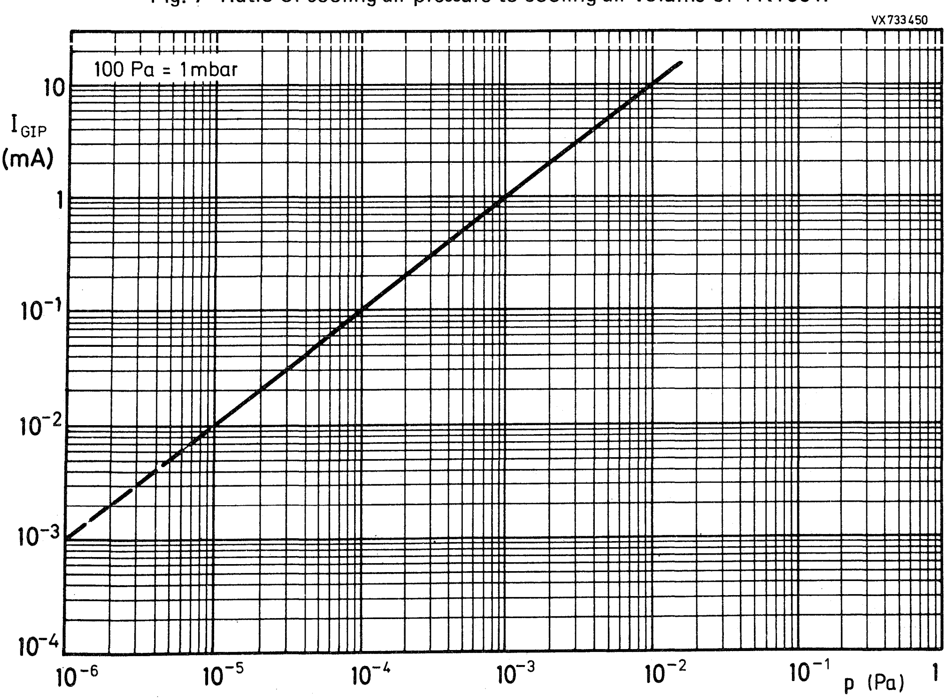


Fig. 8 Ratio of pump current to gas pressure in the klystron.

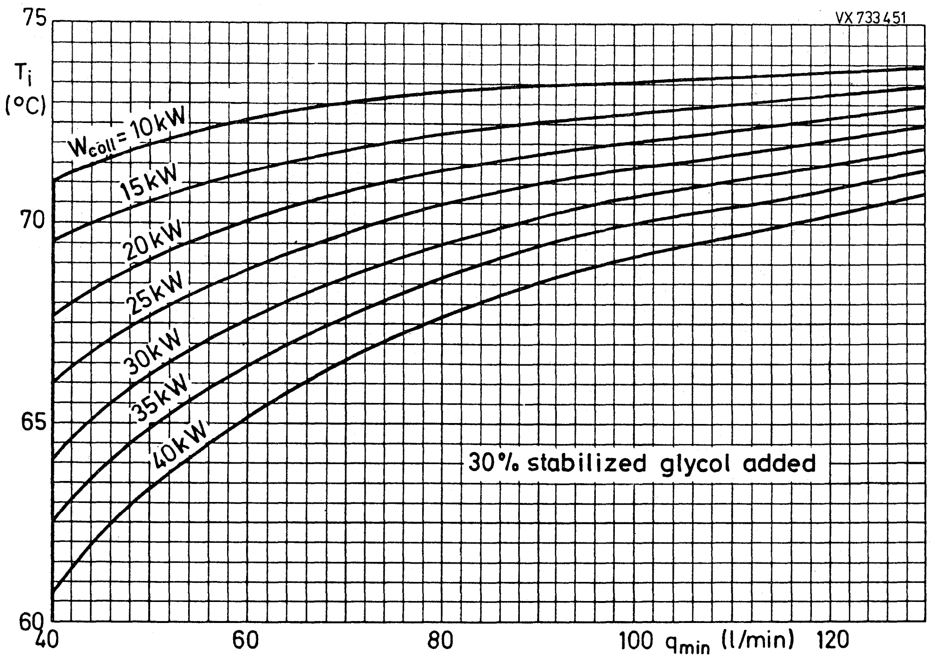


Fig. 9 Cooling curves for closed circuit cooling.

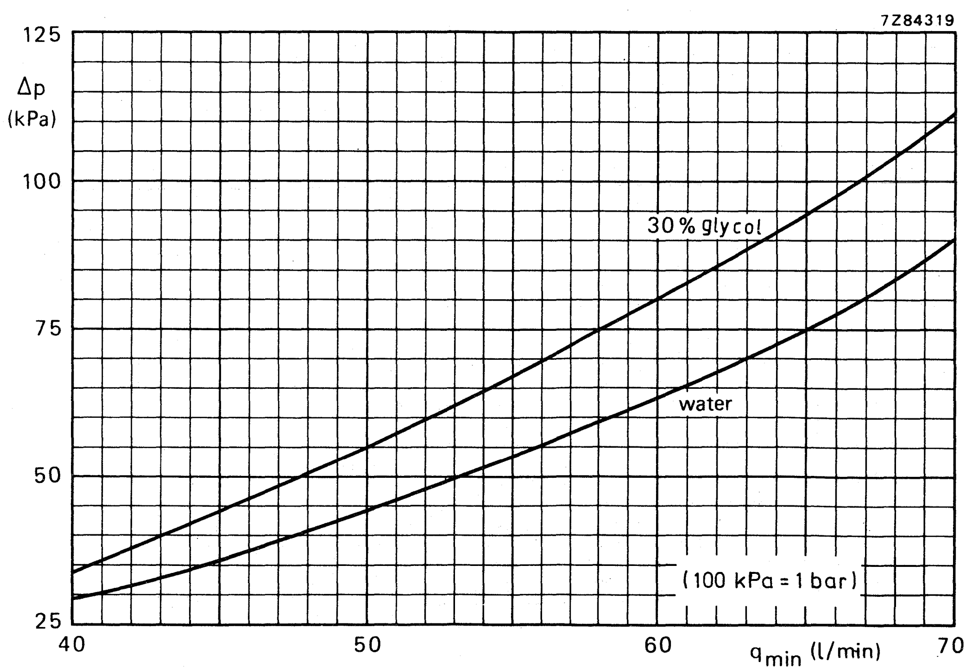


Fig. 10 Ratio of cooling water pressure to cooling water volume.

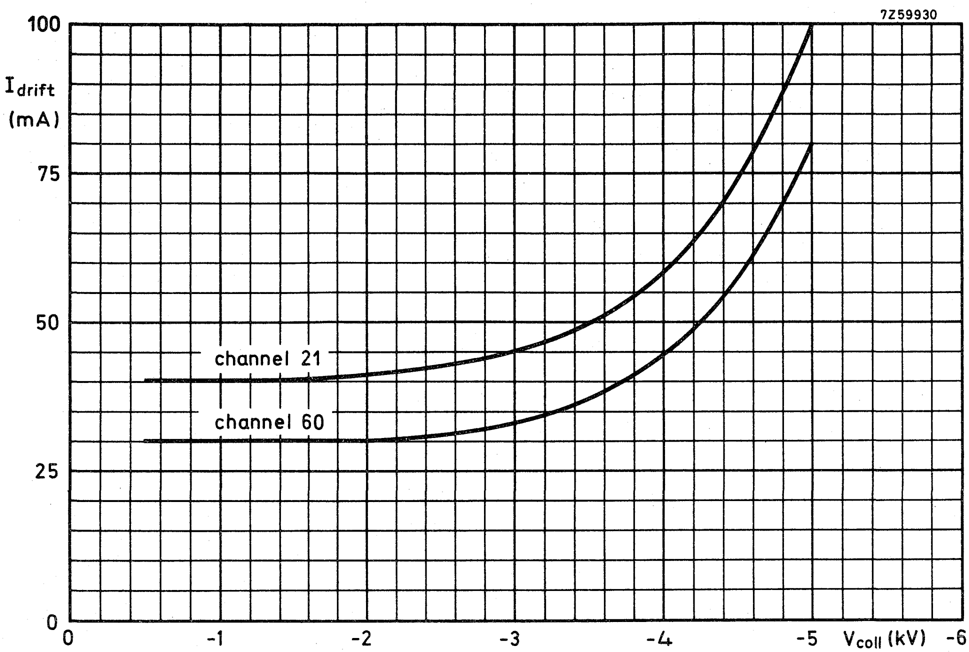

7Z59930
100
I_{drift}
(mA)
75
50
25
0
channel 21
channel 60
0
-1
-2
-3
-4
-5
V_{coll} (kV)
-6

Fig. 11.

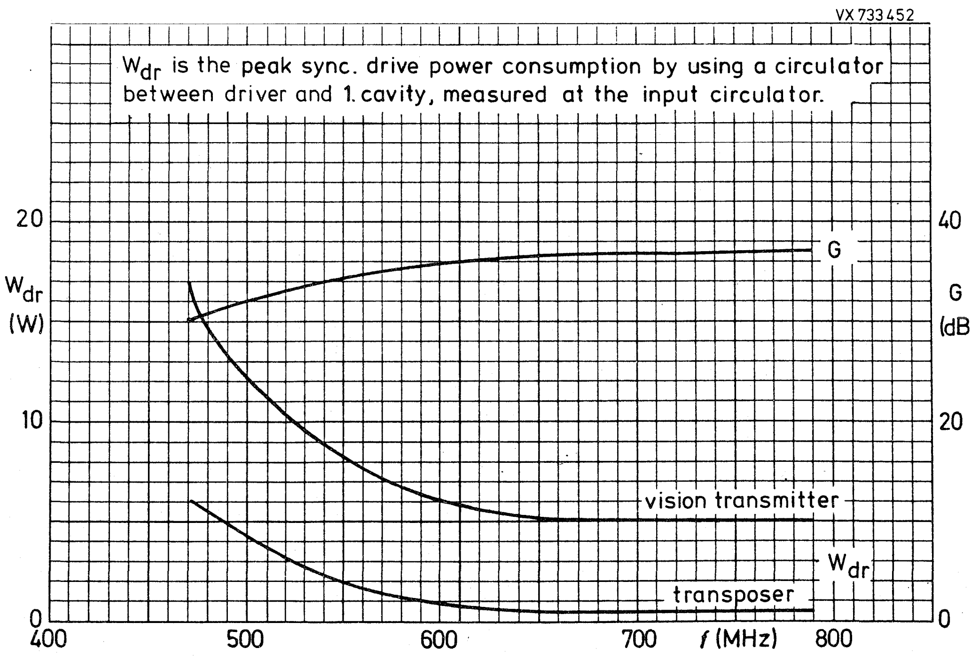

VX 733 452
W_{dr} is the peak sync. drive power consumption by using a circulator between driver and 1. cavity, measured at the input circulator.
20
W_{dr}
(W)
10
0
40
G
(dB)
20
0
G
vision transmitter
W_{dr}
transposer
400
500
600
700
f (MHz)
800

Fig. 12.

PULSED POWER KLYSTRON

Fixed frequency pulsed power klystron in metal-ceramic construction for the range 2998 ± 5 MHz, with 3 internal cavities, electromagnetic focusing, continuously operating getter-ion pump, coaxial input connector and S-band output waveguide, water cooled, intended as amplifier in linear accelerators and similar applications.

QUICK REFERENCE DATA

Frequency range	f	2998 ± 5	MHz

The klystron is factory tuned to 2998 MHz but can delivered for any frequency within the range 2993 MHz to 3003 MHz. Other frequencies on request.

Peak power output	W_{op}	6	MW
Power gain	G	30	dB

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c. or d.c.

Cathode	oxide coated			
Heater voltage	V_f		3 to 4.6	V
Heater current, marked on each tube	I_f		70 to 82	A

The heater current should never exceed a peak value of 150 A when applying an a.c. heater voltage or 100 A when applying a d.c. heater voltage.

Cold heater resistance	R_{fo}		6	mΩ
Waiting time	t_w	min.	45	min

GETTER-ION PUMP POWER SUPPLY

Pump voltage, unloaded			4	kV
Internal resistance		approx.	300	kΩ

COOLING (valid for a pulse repetition rate up to 50 p.p.s.)

Drift tubes and focusing coils	q	min.	4	l/min
	p	max.	350	Pa *
Collector	q	min.	7	l/min
	p	max.	350	Pa *

ACCESSORIES

Magnet and housing for getter-ion pump	type TE1053A and TE1053B

MASS (net) approx. 110 kg

* 350 Pa = 3,5 mbar.

MECHANICAL DATA

Dimensions in mm

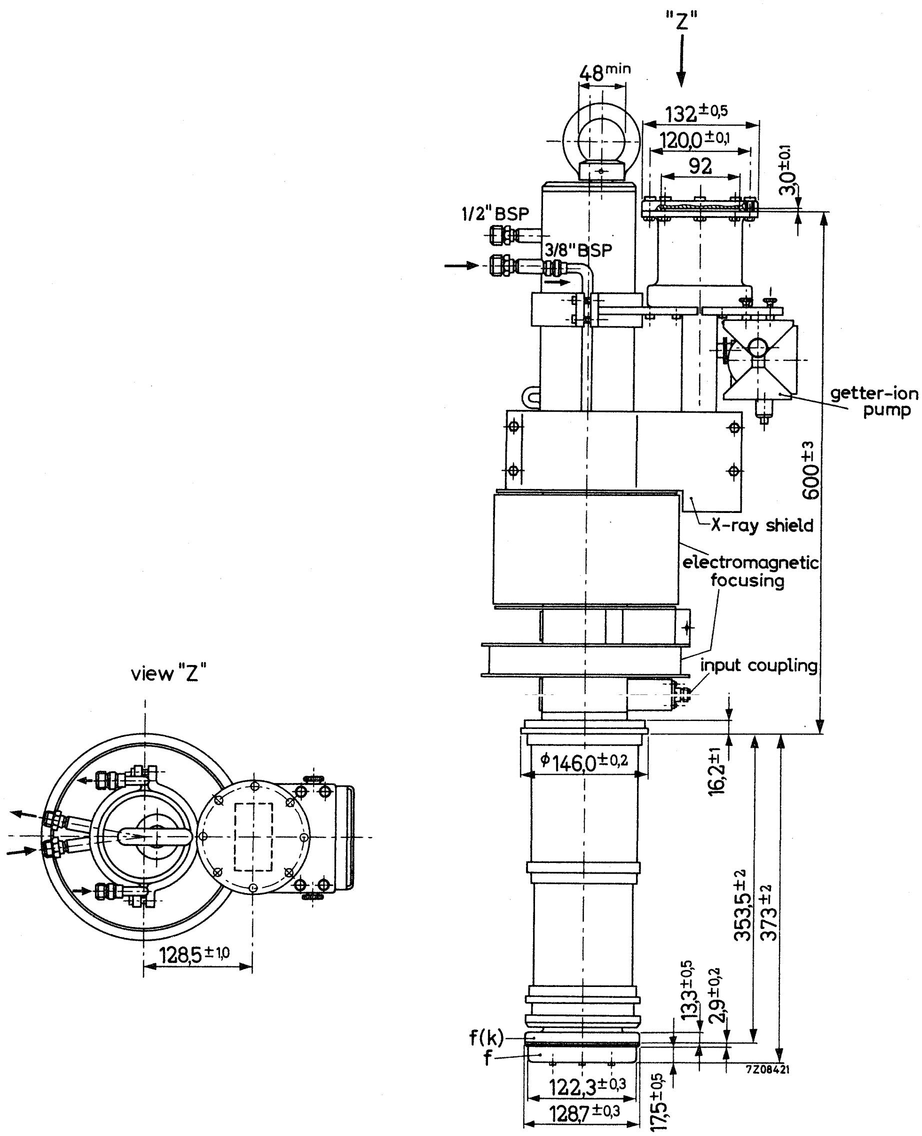


Fig. 1.

MOUNTING Vertical.

To be supported from mounting flange with cathode down. Although the collector and output cavity are provided with a lead shield, adequate additional shielding is required for protection against personal injury due to X-ray radiation.

LIMITING VALUES (Absolute maximum rating system) for pulsed operation.

All voltages are specified with respect to ground.

				notes
Cathode voltage, peak	max.	−220	kV	
Cathode current, peak	max.	120	A	
Beam input power, peak	max.	25	MW	
R.F. input power, peak	max.	10	kW	
R.F. output power, peak	max.	8	MW	
Pulse repetition rate	max.	600	p.p.s.	
Pulse duration	max.	3	μs	
Voltage standing-wave ratio of load	max.	1.5		
Focusing magnet voltage	max.	50	V	
Focusing magnet current	max. min.	32 24	A A	
Pump voltage	max.	4.5	kV	
Pump current	max.	15	mA	
Water outlet temperature	max.	75	°C	

OPERATING CONDITIONS 1

Frequency	2998	MHz	
Heater current			2
Cathode voltage, peak	−210	kV	3
Cathode current,			
peak	100	A	
mean	10	mA	
Focusing magnet voltage	40	V	
Focusing magnet current	29	A	4
Pulse repetition rate	50	p.p.s.	5
Pulse duration	2.2	μs	
R.F. input power	5	kW	
R.F. output power,			
peak	6	MW	
mean	0.66	kW	

Notes

1. When the klystron has not been in operation for some time, conditioning might be required. This should be done by gradually increasing the cathode voltage until in each step stable operation is obtained. Stored tubes require pumping at intervals of approx. 3 months.
2. To be adjusted at the value marked on each tube.
3. For maintaining a minimum output power of 5 MW during life the cathode voltage may be increased to −215 kV.
4. To be adjusted for max. r.f. output power.
5. Data for operation at p.r.r. higher than 50 p.p.s. on request.

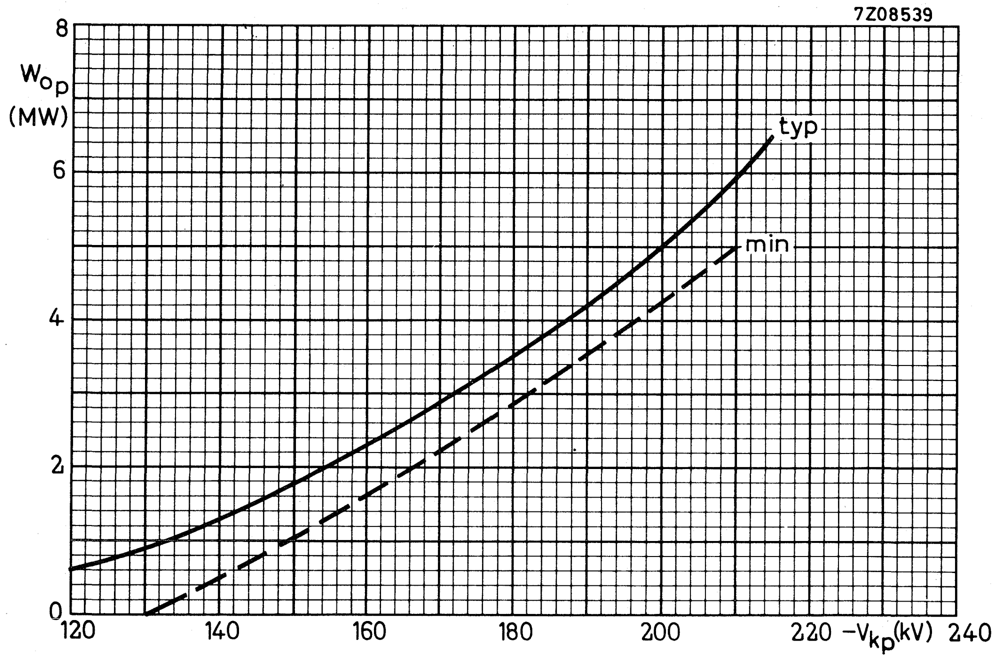

7Z08539
W_{op}
(MW)
8
6
4
2
0
typ
min
120
140
160
180
200
220
$-V_{kp}$(kV)
240

Fig. 2.

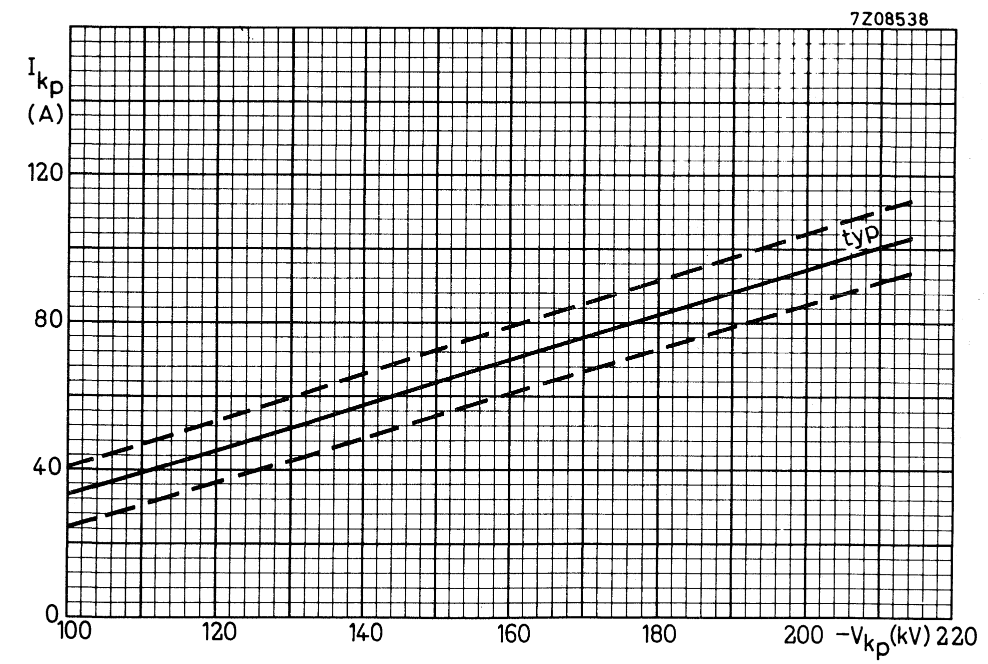

7Z08538
I_{kp}
(A)
120
80
40
0
typ
100
120
140
160
180
200
$-V_{kp}$(kV)
220

Fig. 3.

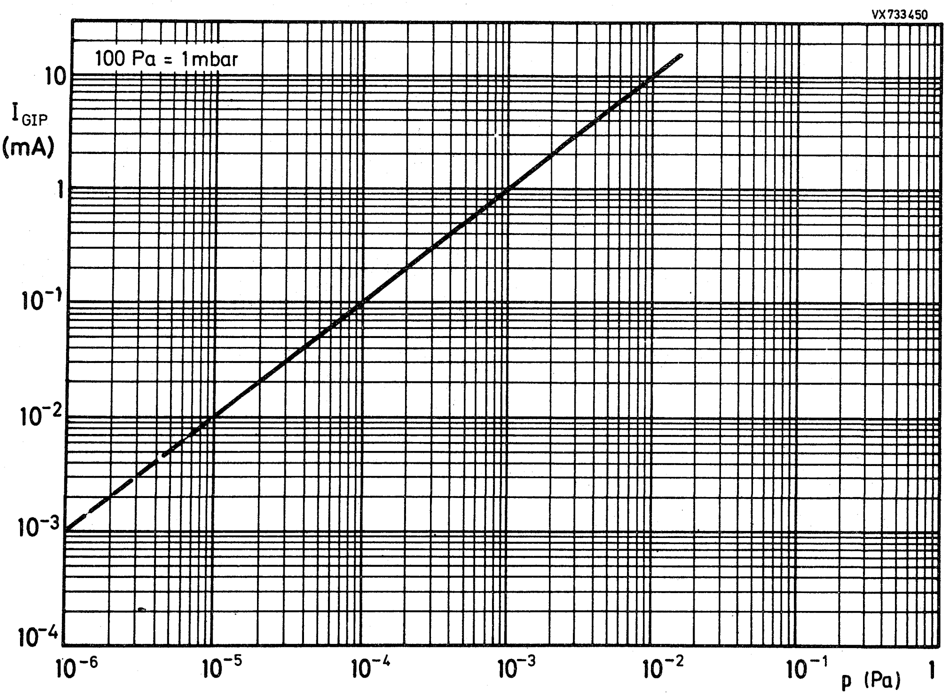


Fig. 4 Ratio of pump current to gas pressure in the klystron.

PRODUCT SAFETY

R.F. radiation

R.F. power may be emitted not only through the normal output coupling but also through other apertures (for example, r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

X-radiation

A highly dangerous intensity of X-rays may be emitted by tubes operating at voltages higher than approximately 5 kV. Adequate protection (X-ray shielding) for the operator is then necessary. The emission intensity of X-rays may correspond to a value of voltage much higher than that expected from the actual value applied to the tube.

Poor focusing may result in excessive X-radiation.

U.H.F. POWER KLYSTRON

U.H.F. TV power klystron in metal-ceramic construction, with four external resonant cavities, integral permanent magnets, and incorporated getter-ion pump. The klystron is intended to be used with depressed collector voltage in 10 kW and 20 kW vision transmitters, in sound transmitters or in high-power transposers in the frequency range 470 to 860 MHz.

QUICK REFERENCE DATA

Frequency range	470 to 860	MHz
Output power, peak sync	25	kW
Cooling	forced air	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by d.c.

					notes
Cathode	dispenser type				
Heater voltage					
vision transmitter	V_f		7	V	1
sound transmitter	V_f		6.5	V	1
Heater current	I_f	≈	30 (26 to 34)	A	
Cold heater resistance	R_{fo}	≈	28	mΩ	
Waiting time					
a. Heater voltage 7 V	t_w	min.	180	s	2
b. Stand-by 6 V vision transmitter	t_w		0	s	2, 3
c. Stand-by 5.5 to 6 V sound transmitter	t_w		0	s	2, 3

FOCUSING

The integral temperature-compensated coaxial permanent magnets are pre-adjusted by the tube manufacturer.

GETTER-ION PUMP SUPPLY

Pump voltage, no load condition	4	kV
Internal resistance	300	kΩ

If it is between 3 kV and 4.5 kV, the collector to body voltage may be used as the pump supply voltage. In this case the pump anode must be connected to body (earth) via a 300 kΩ series resistor.

Notes

1. During operation the heater voltage should not fluctuate more than ± 3%.
2. The heater current should never exceed a peak value of 65 A.
3. Valid after a waiting time of at least 8 min; as soon as the beam voltage is switched on, the heater voltage must be increased to the nominal value.

MECHANICAL DATA

Dimensions in mm

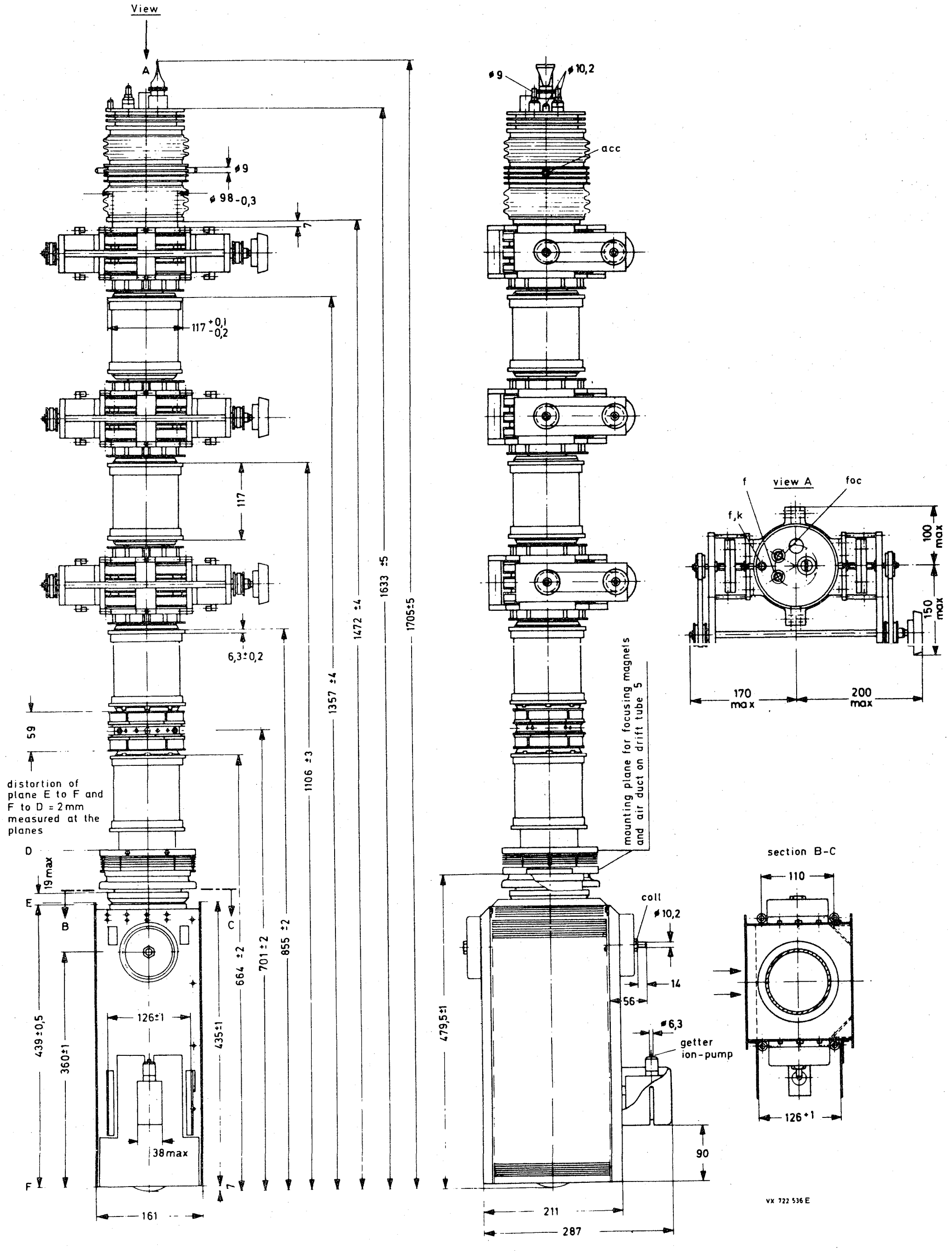


Fig. 1.

MASS AND DIMENSIONS

Klystron

net	approx.	100 kg
gross	approx.	200 kg
outline dimensions of packing (cm)		205 x 79 x 66

MOUNTING

Mounting position: vertical with collector down.
To remove the tube from the magnet frame a total free height of 2.5 m, excluding hoist, is required.

COOLING

Cooling data, using the trolley TE1081

Cathode socket, drift tubes, and cavities	forced air, approx. 5 m^3/min, Δp = 800 Pa (8 mbar)
Collector (60 kW dissipation)	forced air, min 55 m^3/min. Δp = 2100 Pa (21 mbar), see Figs 3, 4 and 5.

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

MECHANICAL DATA of the trolley TE1081

Dimension in mm

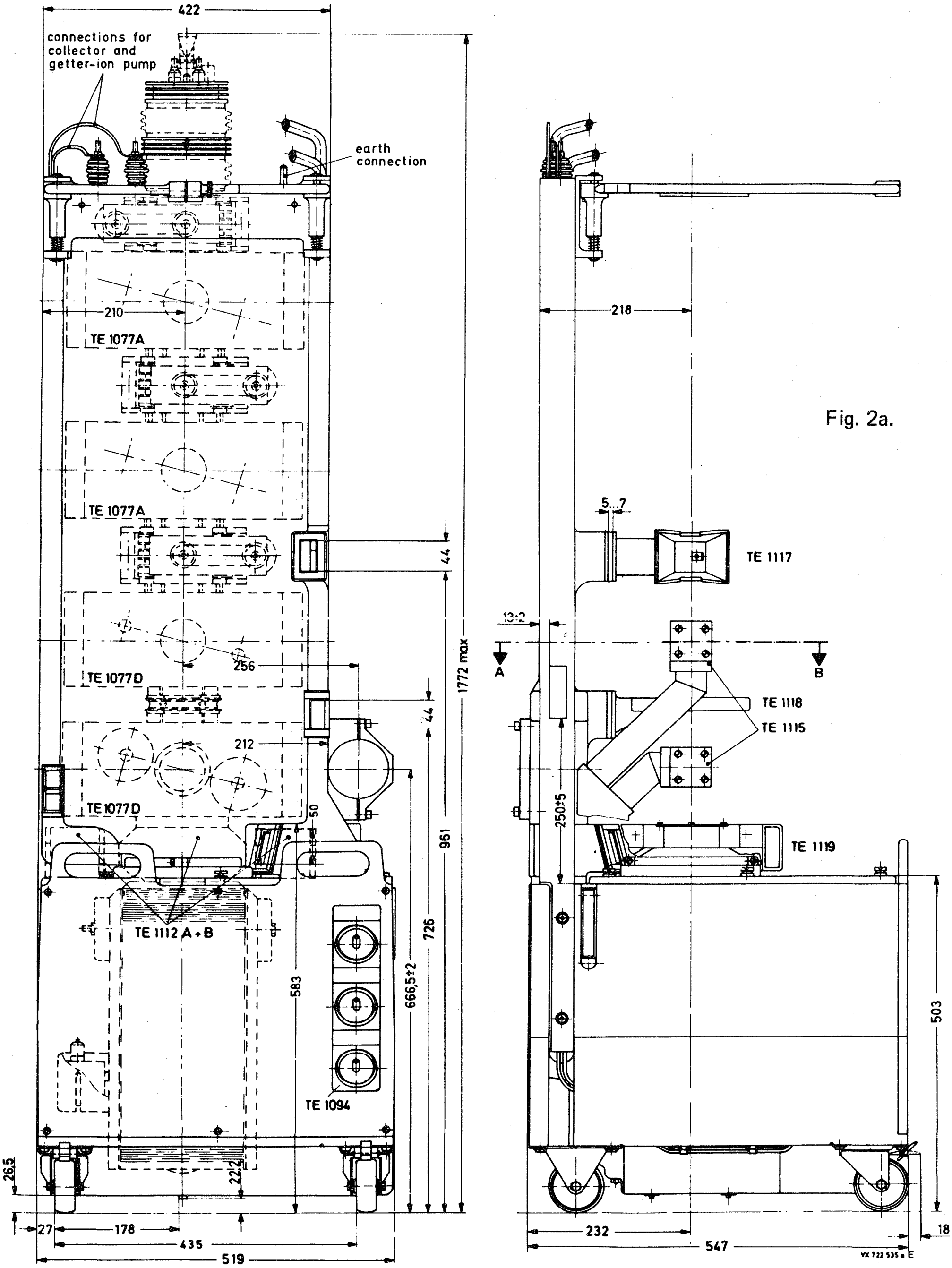
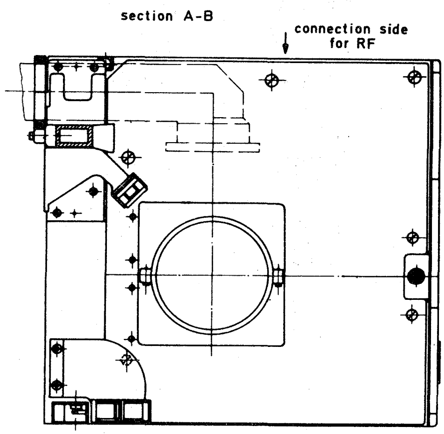


Fig. 2a.


section A-B
connection side for RF

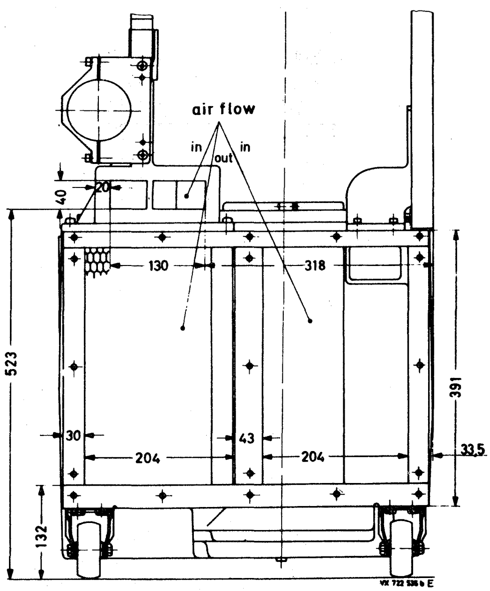

air flow
in
out
in
40
20
130
318
523
391
30
204
43
204
33,5
132

Fig.2b.

ACCESSORIES

Frequency range (MHz) Channel	470 to 637 21 to 41	638 to 860 42 to 68
Stub	TE1089	TE1089
Cavity 1 Input coupling device	TE1077A TE1083	TE1078A TE1084
Cavity 2 Load coupling device	TE1077A TE1085	TE1078A TE1086
Cavity 3 Load coupling device Adaptor flange	TE1077D TE1085 TE1090	TE1078D TE1086 TE1090
Cavity 4 Output coupling device	TE1077D TE1091A	TE1078D TE1092A
Magnet for drift tube 5	TE1112A TE1112B	TE1112A TE1112B
Trolley	TE1081	TE1081
Air duct for cavities Air duct for drift tube 3 Air duct for drift tube 4 Air duct for drift tube 5	TE1115 TE1117 TE1118 TE1119	TE1115 TE1117 TE1118 TE1119
Magnet for getter-ion pump	TE1053A	TE1053A
Connectors Heater Heater/cathode Focusing electrode Accelerating electrode Collector Getter-ion pump Earth	 40649 40649 40634 40634 40649 40634 40649	 40649 40649 40634 40634 40649 40634 40649

Special parts

Load coupling unit mating TE1077D (instead of TE1091A)	TE1087
Load coupling unit mating TE1078D (instead of TE1092A)	TE1088
Plug connection mating TE1091A and TE1092A	TE1091B
Lifting device	TE1113

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

LIMITING VALUES (Absolute maximum rating system)

	min.		max.		notes
Heater voltage			8.5	V	
Ground to cathode voltage			28	kV	
Ground to the accelerator electrode voltage	0	kV	28	kV	
Ground to collector voltage	0	kV	5	kV	
Cathode to focusing electrode voltage	100	V	600	V	
Cathode current			4	A	
Accelerator electrode current	−0.2	mA	+1.5	mA	
Focusing electrode current	−0.2	mA	+3	mA	
Drift tube current					
static			60	mA	4, 5
dynamic			260	mA	5
Collector dissipation			65	kW	
Series resistor in accelerator electrode circuit	10	kΩ			
Return loss of load at operating frequency	14	dB			
Pump voltage, no load condition	3.0	kV	5.0	kV	
Pump current			15	mA	
Temperature of focusing magnets			70	°C	
Inlet temperature of cooling air			45	°C	
Outlet temperature of cooling air			110	°C	

Notes

4. Static operation (operation without output power) in vision transmitters only with beam currents $< 2/3$ of given value allowed (see design considerations).
5. A drift tube current cut-out should be provided to protect the klystron. The cut-out should have an automatic action which depends on the drive level, see Figs 6 and 7.

TYPICAL OPERATING CONDITIONS notes

As 20 kW vision transmitter in accordance with CCIR-G standard, with depressed collector voltage 6

Operating conditions						7
Frequency range	470 to	640	to 790	790 to 860	MHz	
Channel	21 to	41	to 60	61 to 68		
Collector to cathode voltage	16.5	18	20.0	20.0	kV	8
Cathode current	3.6	3.3	3.0	3.1	A	
Ground to collector voltage	4.0	4.0	4.0	4.5	kV	
Drift tube current (black level)	120	100	70	70	mA	
Ground to accelerator electrode voltage	0	≈ 3	≈ 6	≈ 6	kV	
DC input power	59	59	60	62	kW	
Cathode to focusing electrode voltage			300 (100 to 600)		V	9

Drive power see Fig. 10.

Performance	min.	typ.	max.		
Output power, peak sync		22		kW	10
Sync. compression			40/25		11
V.S.B. suppression	23	25		dB	12
Noise ratio, with reference to black level	48	> 50		dB	13
Linearity 10/75	0.75	0.8			14
Differential gain (10/85 at 4.43 MHz)	0.75	0.85			15
Differential phase (10/85 at 4.43 MHz)		+10/−3	+15/−5	deg	15, 16
Variation in response characteristic as a function of power level					
in the double-sideband region		0.25	0.5	dB	17
in the single-sideband region		0.4	0.6	dB	18
Ripple of response characteristic (white level 10/20)			0.3	dB	
Maximum output power		25		kW	19
Efficiency		37		%	

TYPICAL OPERATING CONDITIONS (continued)

					notes
As 20 kW vision transmitter in accordance with CCIR-G standard, without depressed collector voltage					6
Operating conditions					7
Frequency range		470 to 860		MHz	
Channel		21 to 68			
Collector to cathode voltage		19.5 to 23		kV	8
Cathode current		3.05 to 2.6		A	
Ground to collector voltage		0		kV	
Drift tube current (black level)		80 to 40		mA	
Ground to accelerator electrode voltage		1.5 to 6.5		kV	
DC input power		60		kW	
Cathode to focusing electrode voltage		300 (100 to 600)		V	9
Drive power see Fig. 10.					
Performance					
Output power, peak sync		22		kW	10
	min.	typ.	max.		
Sync. compression			52/26		11
V.S.B. suppression	23	25		dB	12
Noise ratio, with reference to black level	48	>50		dB	13
Linearity 10/75	0.65	0.75			14
Differential gain (10/85 at 4.43 MHz)	0.65	0.75			15
Differential phase (10/85 at 4.43 MHz)		+12/−3	+15/−5	deg	15, 16
Variation in response characteristic as a function of power level					
in the double-sideband region		0.25	0.5	dB	17
in the single-sideband region		0.4	0.6	dB	18
Ripple of response characteristic (white level 10/20)			0.3	dB	
Maximum output power	22	23		kW	19
Efficiency		37		%	

TYPICAL OPERATING CONDITIONS (continued)

As 10 kW vision transmitter in accordance with CCIR-G standard

					notes
Operating conditions					7
Frequency range	470 to 640	470 to 790	790 to 860	MHz	
Channel	21 to 41	21 to 60	61 to 68		
Collector to cathode voltage	15.0	16.0	16.0	kV	8
Cathode current	2.2	2.1	2.2	A	
Ground to collector voltage	4.0	4.0	4.5	kV	
Drift tube current (black level)	60	50	50	mA	
Ground accelerator electrode voltage	≈ 4.0	≈ 5.5	≈ 6.0	kV	
D.C. input power	33	33.5	35	kW	
Cathode to focusing electrode voltage		300 (100 to 600)		V	9

(notes column: heading line 6)

Drive power see Fig. 10.

Performance					10
Output power, peak sync		11		kW	
	min.	typ.	max.		
Sync. compression			40/25		11
V.S.B. suppression	23	25		dB	12
Noise ratio, with reference to black level	48	> 50		dB	13
Linearity 10/75	0.75	0.8			14
Differential gain (10/85 at 4.43 MHz)	0.75	0.85			15
Differential phase (10/85 at 4.43 MHz)		+10/–3	+15/–5	deg	15, 16
Variation in response characteristic as a function of power level					
in the double-sideband region		0.25	0.5	dB	17
in the single-sideband region		0.4	0.6	dB	18
Ripple of response characteristic (white level 10/20)			0.3	dB	
Maximum output power		12.5		kW	19
Efficiency		33		%	

TYPICAL OPERATING CONDITIONS (continued) notes

As sound transmitter in accordance with the CCIR-G standard (one carrier operation) 6

R.F. setting

Cavity 4	on sound carrier frequency
Cavity 1	on sound carrier frequency −0.5 MHz
Cavity 2	on sound carrier frequency +0.5 MHz,
Cavity 3	on sound carrier frequency min. +3 MHz, (load coupler and load are not necessary)

Double-humped resonance curve slack ≤ −0.5 dB

Operation with high voltage collector to cathode

with depressed collector voltage 7

Frequency range		470 to 640		470 to 790		790 to 860		MHz	
Channel		21 to 41		21 to 60		61 to 68			
Collector to cathode voltage		16.5	18	20.0		20.0		kV	
Ground to collector voltage		4.0	4.0	4.0		4.5		kV	
Cathode to focusing electrode voltage		100 to 600		100 to 600		100 to 600		V	
Driving power	≤	0.5		0.5		0.5		W	
Ground to accelerator electrode voltage	≈	10.5	12.5	14.0	16.0	14.5	16.5	kV	
Cathode current		1.1	0.8	1.0	0.7	1.0	0.7	A	20
Output power		4.4	2.2	4.4	2.2	4.4	2.2	kW	

without depressed collector voltage

Frequency range		470 to 860		MHz	
Channels		21 to 68			
Collector to cathode voltage		19.5 to 23		kV	
Ground to collector voltage		0		kV	
Cathode to focusing electrode voltage		100 to 600		V	
Driving power		≤ 1		W	
Ground to accelerator electrode voltage	11.5 to 15.5		13 to 17	kV	
Cathode current	0.8 to 0.7		0.6 to 0.5	A	20
Output power	2.2		1.1	kW	

TYPICAL OPERATING CONDITIONS (continued) notes

As sound transmitter (continued) 6

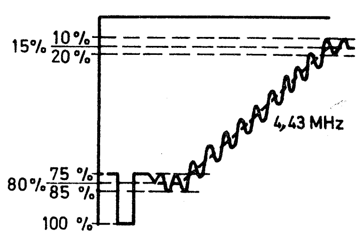
Operation with low voltage collector to cathode 7

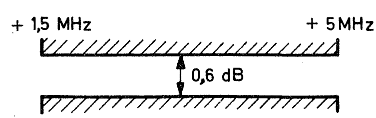
with depressed collector voltage

Frequency range	470 to 640		470 to 790		790 to 860		MHz	
Channel	21 to 41		21 to 60		61 to 68			
Collector to cathode voltage	15.0		16.0		16.0		kV	
Ground to collector voltage	4.0		4.0		4.5		kV	
Cathode to focusing electrode voltage	100 to 600		100 to 600		100 to 600		V	
Driving power	⩽ 0.5		⩽ 0.5		⩽ 0.5		W	
Ground to accelerator electrode voltage	≈ 0.9	≈10.5	≈12.5	≈13.5	≈13.0	≈14.0	kV	
Cathode current	0.8	0.6	0.65	0.5	0.65	0.5	A	20
Output power	2.2	1.1	2.2	1.1	2.2	1.1	kW	

Notes

6. With stated accessories; in case of failure the beam voltage must be switched-off and made to drop below 5% of its nominal value within 500 ms of the failure.
7. For optimum performance one of these settings has to be chosen in accordance with the transmitter manual.
8. Fluctuations up to ± 3% will not damage the tube; to obtain a good signal transfer quality the beam voltage should not vary more than ± 1%.
9. To be adjusted for the specified cathode current.
10. The signal transfer quality is measured with matched load (VSWR ⩽ 1.05).
11. Calculated from $(1\text{-}V_{black}/V_{sync})_{in}/(1\text{-}V_{black}/V_{sync})_{out}$
12. Measured with 10 to 75% modulation without compensation; V.S.B. filter between driving stage and klystron.
13. Produced by the klystron itself; without hum from power supplies.
14. Measured with a staircase signal of 10 to 75% of the peak sync value.
15. Measured with a sawtooth voltage with an amplitude between 15 and 80% of the peak sync. value on which is superimposed a 4.43 MHz sinewave with a 10% peak to peak value.
16. Phase difference to burst signal.
17. With respect to ± 0.5 MHz about the carrier frequency.
18. With respect to specified tolerance range.
19. With increased driving power under the given operating conditions, without guarantee for signal transfer quality.
20. Cathode current adjusted by accelerating electrode voltage (coarse), and focusing electrode voltage (fine).





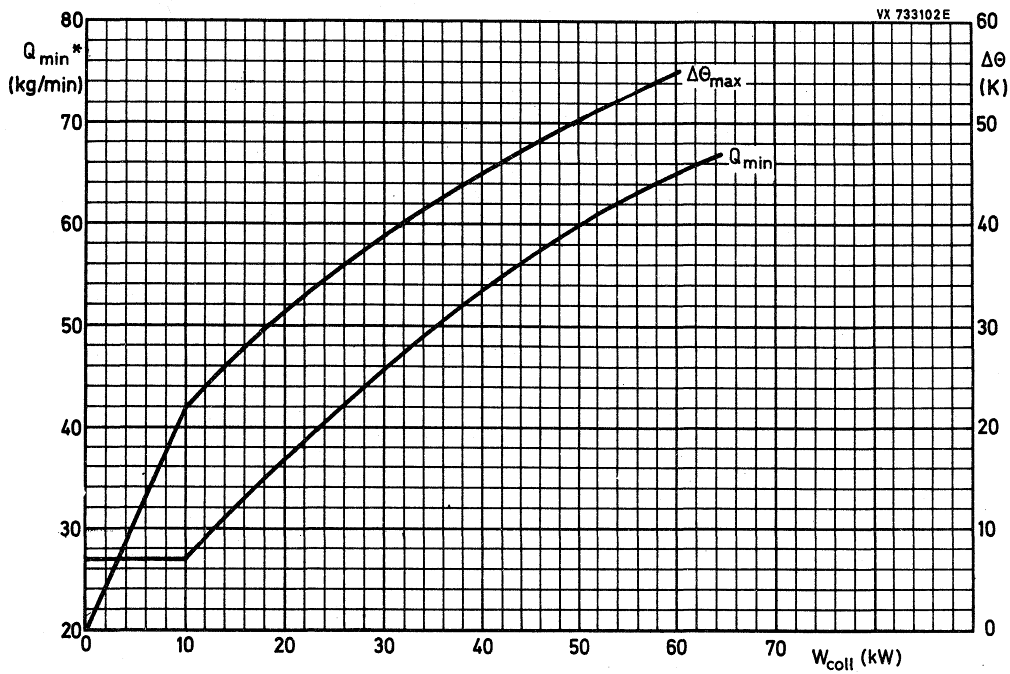


Fig. 3 Required quantity of cooling air Q_{min} for the inlet temperature T_i = 25 °C and relative temperature difference $\Delta\theta$ versus the collector dissipation W_{coll}.

* A normal cubic metre (at 1033 mbar, 15 °C) corresponds to 1.226 kg.

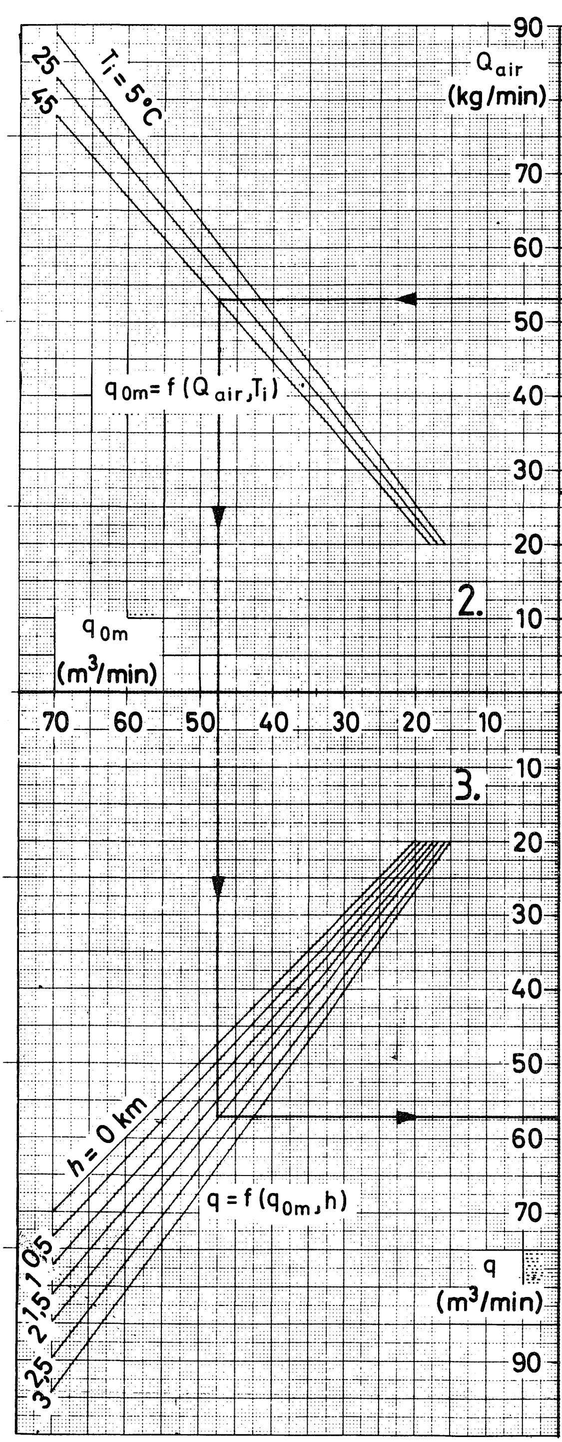


Fig. 4.

Quadrant 1.

The quantity of cooling air Q_{air} (kg/min) for a given collector dissipation W_{coll} must be calculated in such a way, that the operating point for the highest expected inlet temperature does not lie below the drawn limiting curve.

Quadrant 2.

Calculation of the cooling air volume q_{0m} (T_i) in (m^3/min) at the altitude h = 0 m with respect to the highest inlet temperature T_i to be expected.

Quadrant 3.

Consideration of the geographic transmitter altitude (lower density): Calculation of the required air volume q (h) for the same quantity of cooling air Q_{air}.

Example

Given that W_{coll} = 40 kW, h = 2000 m and T_i = 45 °C.

From Quadrant 1:
$Q_{air} \geqslant 53$ kg/min and θ_{max} = 44.5 K.

From Quadrant 2:
inlet temperature T_i = 45 °C; by substitution $q_{0m}(45) = 47.5\ m^3/min$.

From Quadrant 3:
at h = 2000 m, q(2000, 45) = 57 m^3/min.

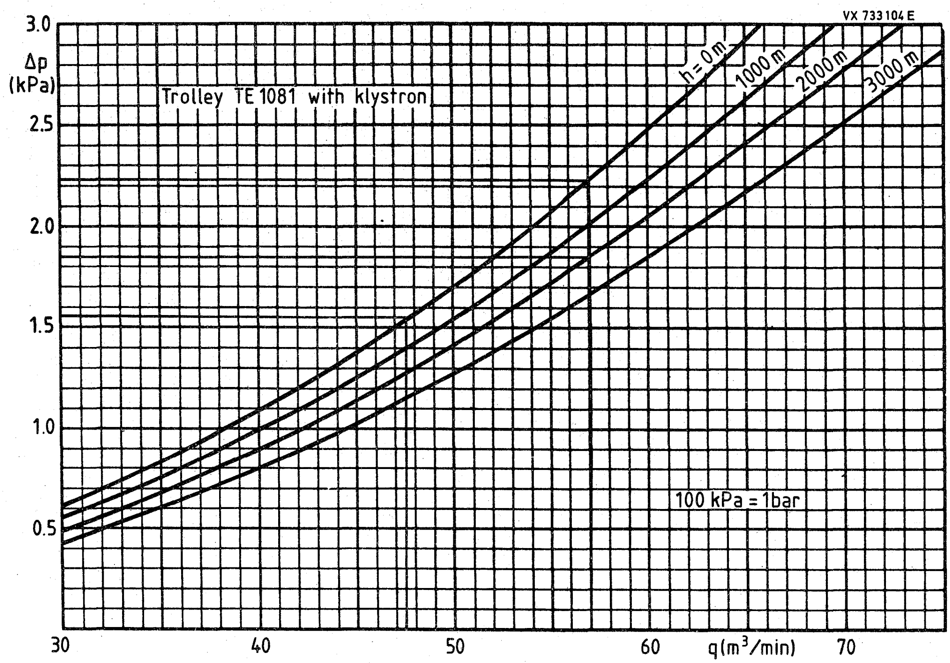


Fig. 5 Calculation of the pressure drop Δp between air inlet and air outlet at the trolley TE1081 as a function of cooling air volume q for selection of the correct blower.

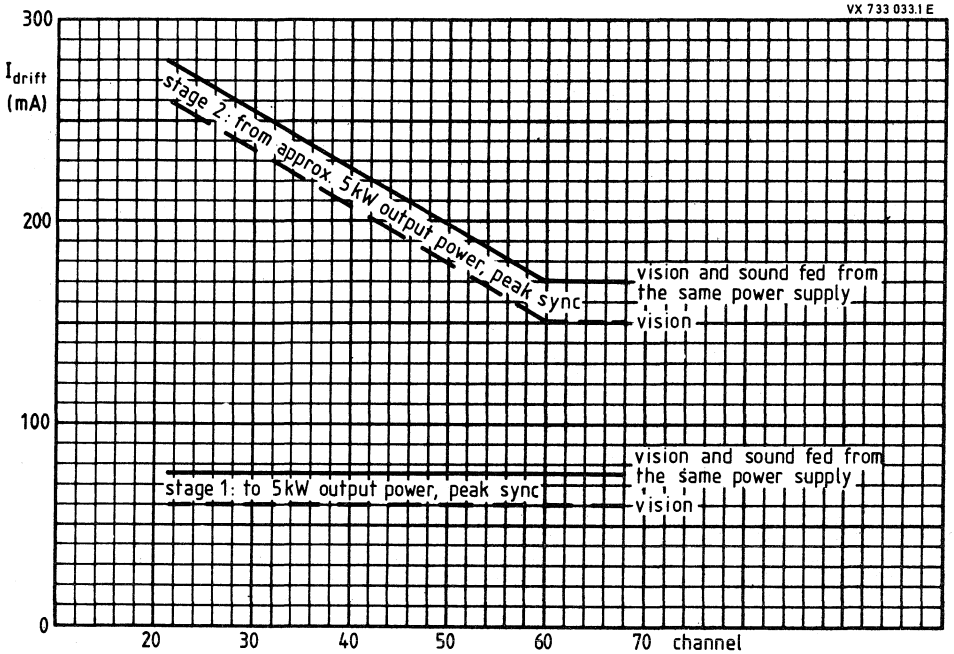


Fig. 6 Drift tube current cut-out at operation with depressed collector voltage for 20 kW transmitter.

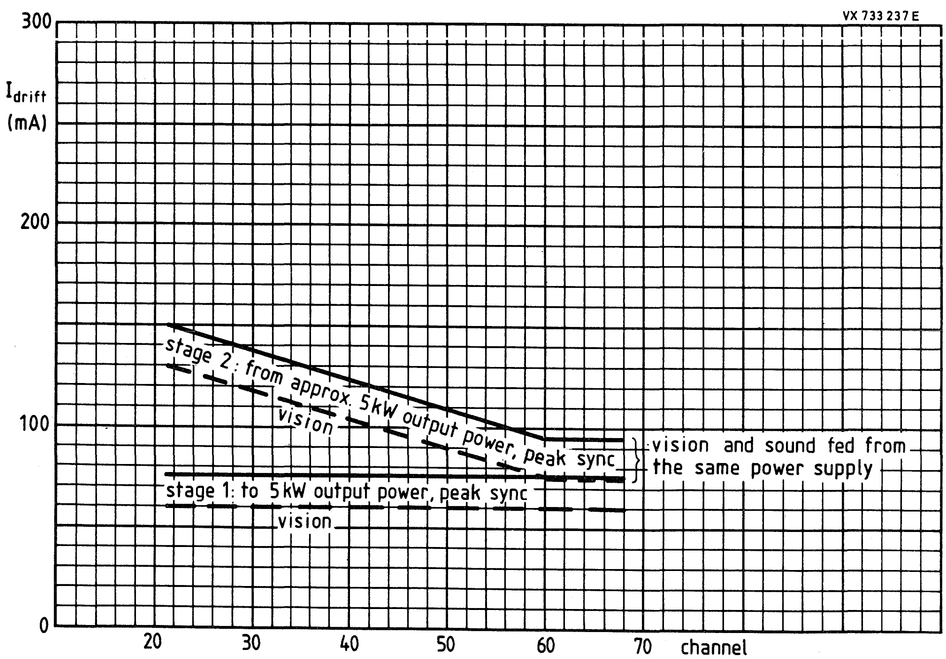


Fig. 7 Drift tube current cut-out at operation without depressed collector voltage for 20 kW transmitter.

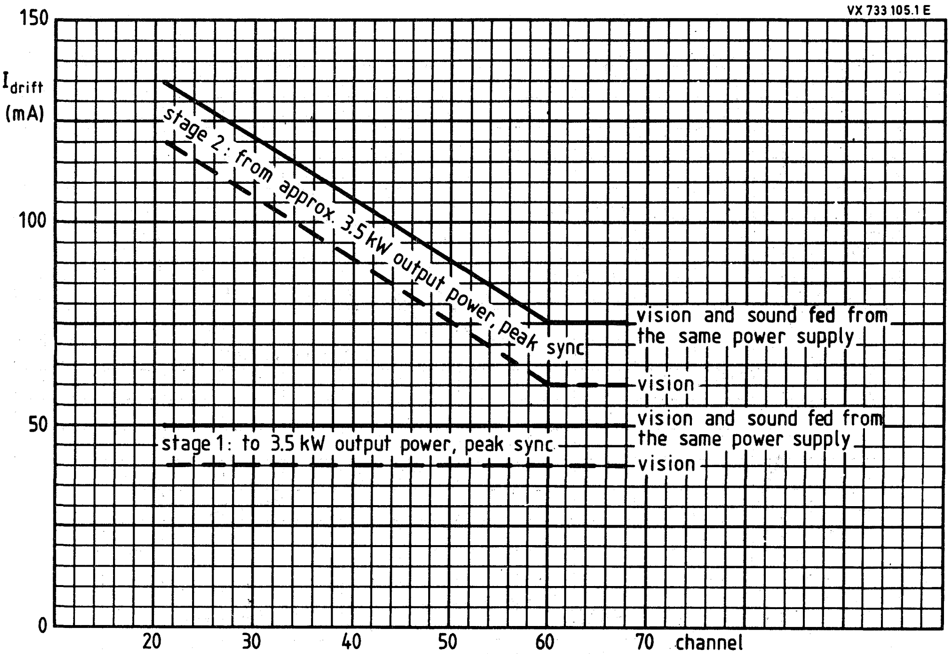


Fig. 8 Drift tube current cut-out at operation with depressed collector voltage for 10 kW transmitter.

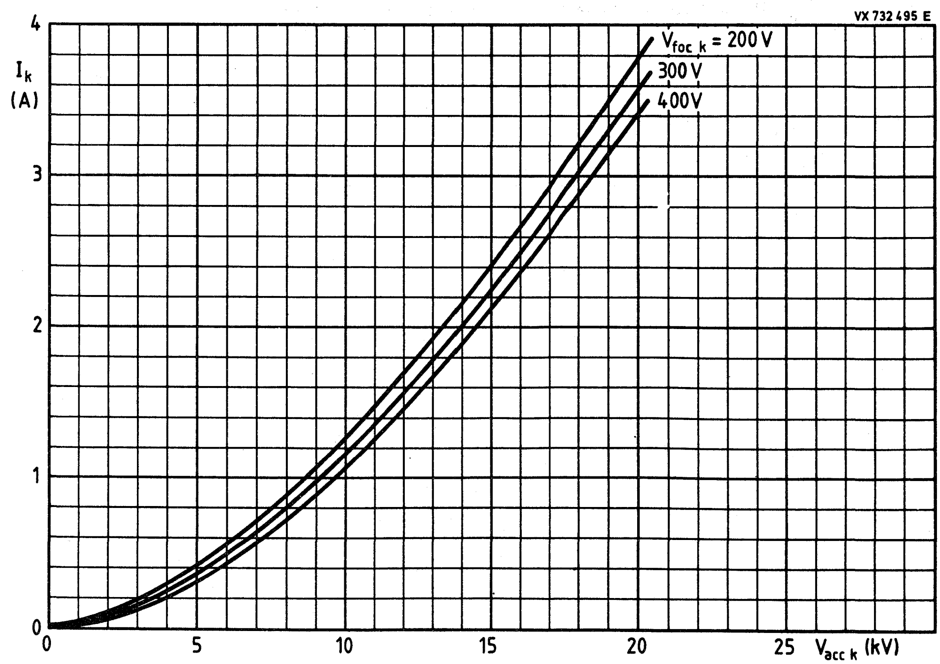


Fig. 9.

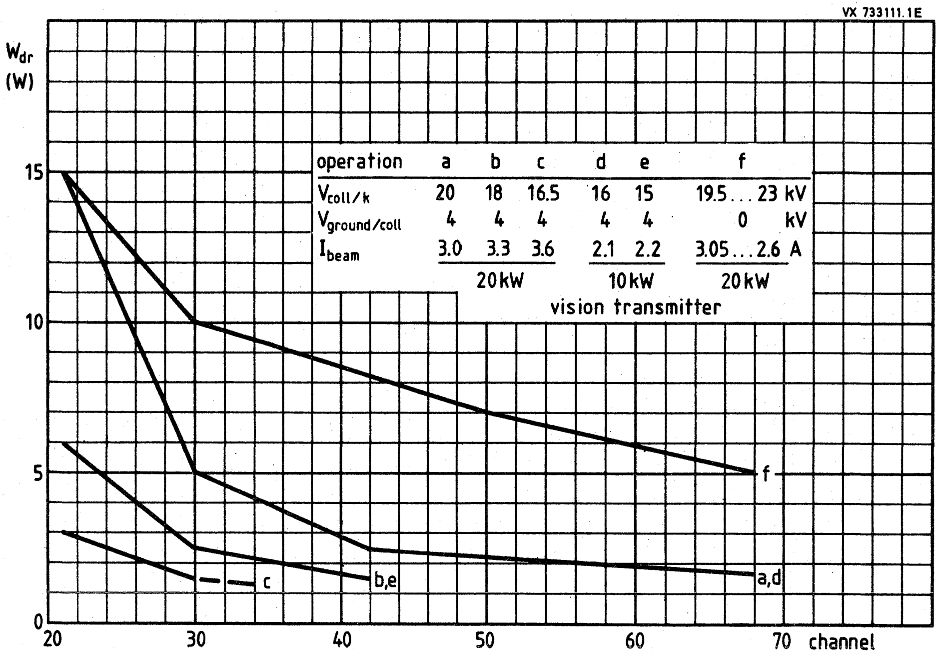


Fig. 10 Max. drive power in dependence on channel and operation mode.

DESIGN CONSIDERATIONS FOR POWER SUPPLIES AND SAFETY CIRCUITS

1. Power supplies

	Range [1]		Internal resistance	Hum
Heater voltage	6.5 to 8.0 V (26 to 36 A)		[2]	Corresponding to non-smoothed three-phase, full-wave rectifier
Cathode to focusing electrode voltage	100 to 600 V (−0.2 to +3 mA)			< 0.1%
Ground to collector voltage	0 or 4.5/ 4.0/ 3,5 kV 3) (500 mA mean, 1 A peak)		0 or 300 to 600 Ω	< 0.1%
Collector to [4] cathode voltage	Operation without depressed collector voltage	Operation with depressed collector voltage		
20 kW operation	19.5 to 23 kV (65 kW)	16.5 kV 18.0 kV (65 kW) 20.0 kV	300 to 600 Ω	< 0.1%
10 kW operation		15.0 kV 16.0 kV (35 kW)		
Ground to accelerator electrode voltage	see Fig. 9.			
Getter-ion pump to cathode voltage [5]	voltage, unloaded 3.5 to 4 kV (load up to 15 mA)		300 kΩ	– –

1) Maximum allowable deviation from nominal or set values:
a) ±2% during adjustment, if the published performance is to be attained,
b) ±1% fluctuation of the set values during operation to maintain the performance,
c) during operation, deviations not exceeding ±3% of the set values will not damage the tube.

2) The heater current should never exceed a peak value of 65 A.

3) At operation with depressed collector voltage a capacitor of 0.5 μF must be installed near the collector connection of the klystron and the trolley between feed line and ground.

4) An additional tap for approx. 500 V to the given voltages is recommended.

5) Needed for operation without depressed collector voltage.

2. Safety circuits

The safety circuits must operate in any one of the following cases:

a) The cut-out threshold of the drift tube current is exceeded. Dependent on the peak output power this cut-out should operate in two stages, see Figs 6 and 7.

b) The set collector or cathode current is exceeded by more than 30 % (max. 400 mA).

c) The air volume for collector cooling falls below the initial value for a longer period (see data sheet by cooling).

d) The cooling air for drift tubes 3, 4 and 5, cavity 4, and cathode terminals fails (checked by a vane or equivalent device).

e) The set max. temperature on the contact thermometers of the klystron is exceeded.

Set temperatures of the probe assemblies are:

	Probe 1 (top)	Probe 2 (middle)	Probe 3 (bottom)
10 kW Vision	80 °C	80 °C	80 °C
10 kW Sound	65 °C	65 °C	65 °C
20 kW Vision	90 °C	110 °C	110 °C
20 kW Sound	65 °C	65 °C	65 °C

f) The return loss is lower 14 dB (VSWR $\geqslant$ 1.5).

g) The pump operating current exceeds 50 μA.

3. Operation without output power

Static operation (operation without output power) in vision transmitters is not allowed at beam currents > 2/3 of the given value. Without driving signal the beam current must be reduced or the tube switched-off.

4. Switching-on and switching-off procedures

a) Switching-on sequence:

1. accelerating electrode at cathode potential,
2. cooling air,
3. ground to collector voltage,
4. heater voltage and cathode to focusing electrode voltage.

Steps 1 to 4 can be simultaneous.

5. waiting time,
6. collector to cathode voltage,
7. ground to accelerator electrode voltage.

b) Switching-off sequence:

1. accelerating electrode at cathode potential,
2. all other voltages and cooling simultaneously.

c) Switching-off sequence when the safety circuits operate:

1. accelerating electrode at cathode potential,
2. cathode-to-collector voltage.

For repeated switching-on (repeating): see a) 6 and 7.

In case of failure the following voltages must be switched-off and made to drop below 5% of their nominal value:

accelerating electrode-to-body voltage and cathode-to-collector voltage within 500 ms, collector-to-body voltage within 1 s.

It is recommended to start this drop 200 ms after occurrence of the failure.

5. Waiting time after short interruptions of operation

Interruption of the heater voltage	Required waiting time	{ vision V_f = 7 V sound V_f = 6.5 V
0 to 30 s	0 s	
30 to 60 s	30 s	
60 to 90 s	60 s	
> 90 s	180 s	

6. Focusing

a) The tube is pre-focused by the tube manufacturer.

b) For final focusing see manual.

7. Cooling

a) The cooling of the cathode socket, accelerating electrode, drift tubes, and cavities must be monitored.

b) The air volume of the collector cooling and, dependent on it, the temperature distribution at the air outlet, must be monitored at minimum three points.

c) Also during stand-by the cathode socket must be cooled and the getter-ion pump kept in operation.

8. Mounting

a) The r.f. connectors for operation have the following dimensions:

Stub	7/16
Input coupling device cavity 1	7/16
Output coupling device cavities 2 and 3	7/16
Output coupling device cavity 4	3 1/8"

b) Forces on klystron terminals max. 10 N. Bending moment max. 1 Nm.

c) The coaxial magnets must not be removed from the klystron.

d) In order to prevent distortion of the magnetic focusing field, ferromagnetic material should not be applied within a radius of 35 cm from the tube axis.
Using the trolley TE1081. No parts should be mounted on or within the trolley and ferromagnetic parts in the trolley are not allowed.

e) Magnetic stray fields, e.g. from transformers, coils, etc., must not exceed 50 μT (0.5 gauss) at the surface of the klystron.

f) It is recommended to use non-magnetic material for doors of cabinets containing output stages, if these doors must be closed after focusing.

9. Storage and transport

a) In cases of prolonged storage, each klystron must be checked for vacuum at least every 6 months and pumped if necessary.
It is recommended to check every 3 months (the heater voltage need not switched-on).

b) All klystrons are insured during delivery transportation.
Each tube must be inspected for damage within 7 days of delivery:
1. Visual inspection of pack and tube.
2. Vacuum inspection with the getter-ion pump (without heating), the pump current must decrease to less than 10 μA within 15 min.

U.H.F. POWER KLYSTRONS

For u.h.f. band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.

QUICK REFERENCE DATA

Frequency range		
YK1190	470 to 610	MHz
YK1191	590 to 720	MHz
YK1192	710 to 860	MHz
Output power as vision transmitter	40	kW
Cooling	vapour, vapour condensation, or water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by d.c.

					notes
Cathode	dispenser type				
Heater voltage	V_f	≈	8.5	V ± 3 %	
Heater current	I_f	≈	22 to 27	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	

FOCUSING: electromagnetic

Focusing coil current		9 to 12	A
Resistance of focusing coils			
cold (20 °C)		7.2 to 9.5	Ω
operating at an ambient temperature of 20 °C	⩽	11	Ω

BEAM CONTROL

The accelerator electrode voltage allows adjustment of the beam current between 0 and 100%.

ION-GETTER PUMP SUPPLY 3

Pump voltage, no-load condition	3 to 4	kV
Internal resistance of supply	300	kΩ

MECHANICAL DATA YK1190

Dimensions in mm

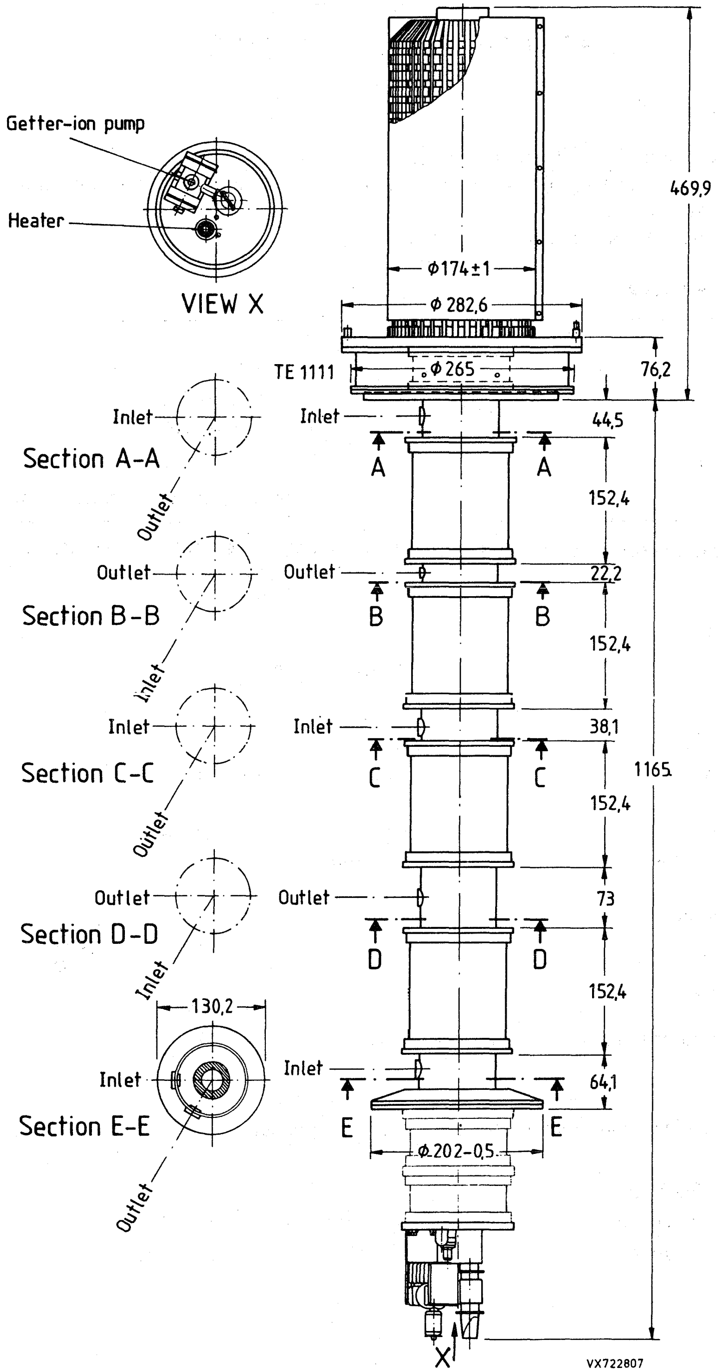


Fig. 1.

YK1191, YK1192

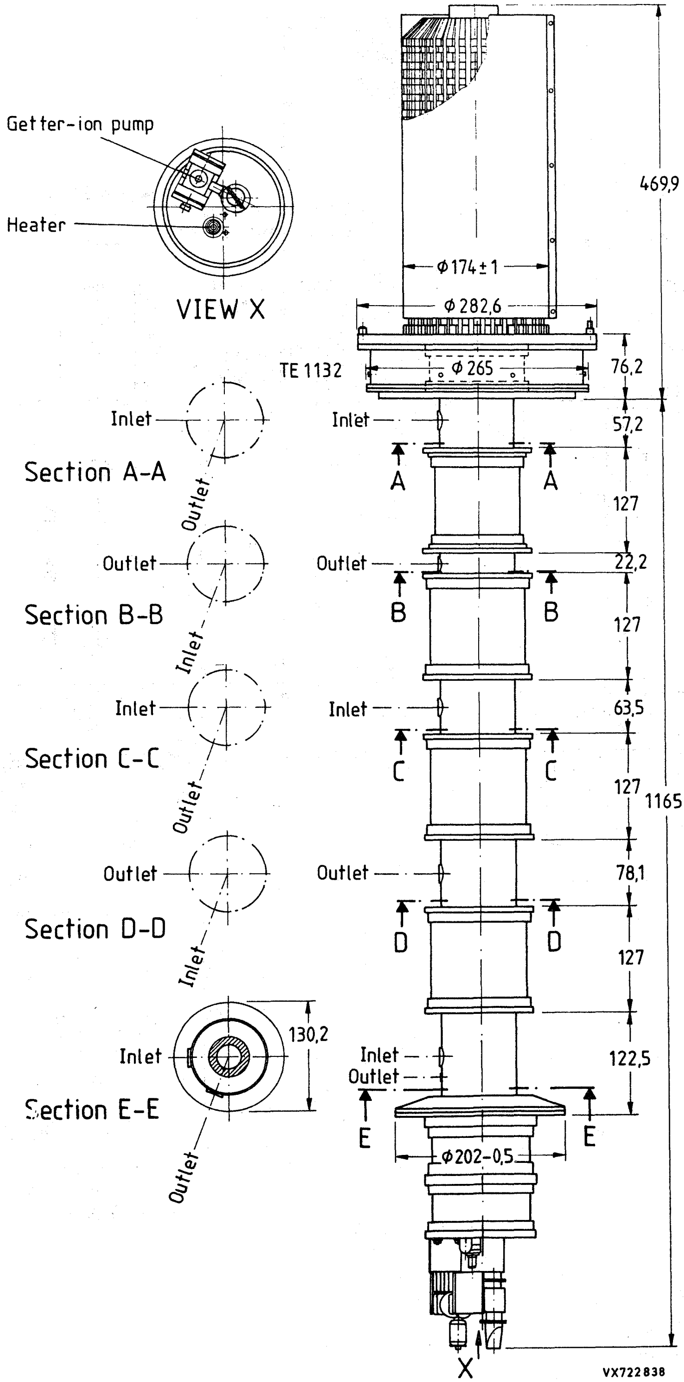


Fig. 2.

Mechanical outlines of trolley

Dimensions in mm

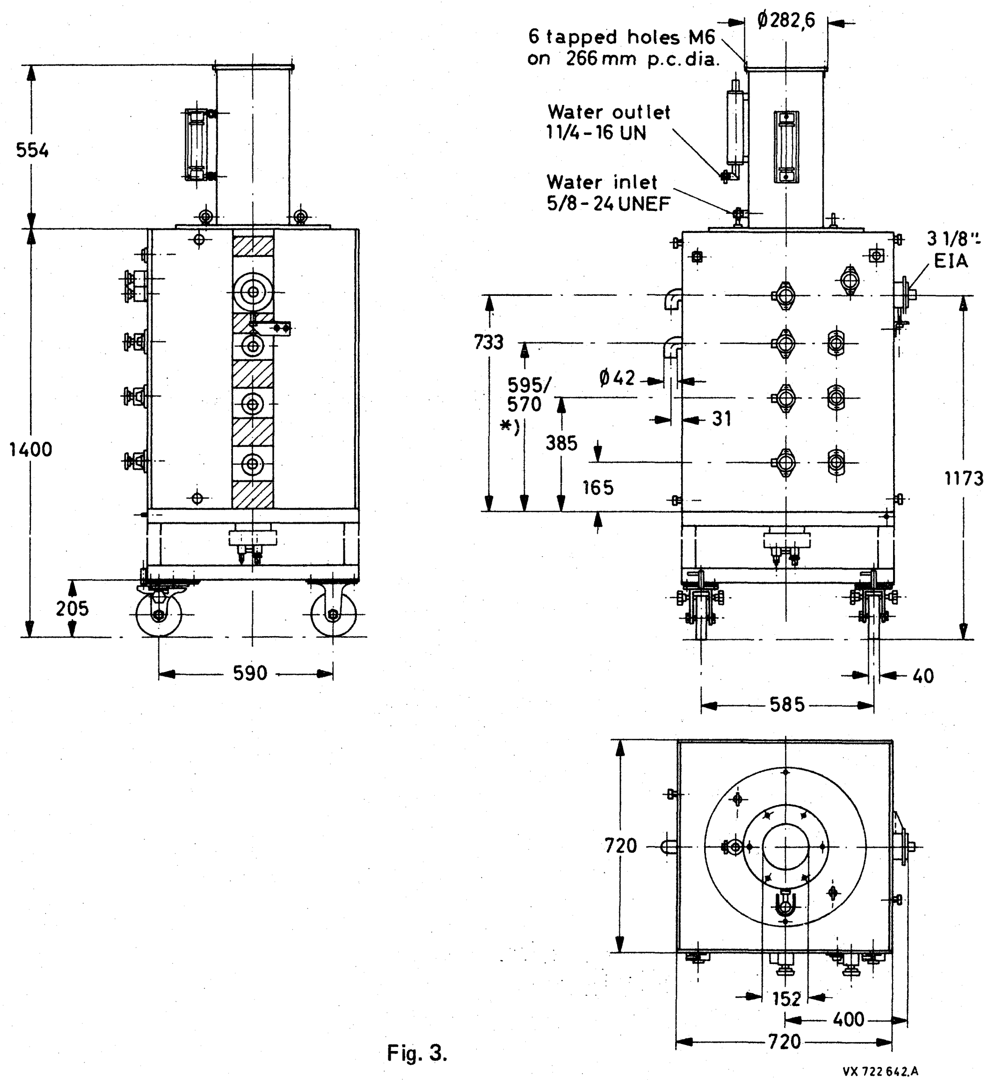


Fig. 3.

* YK 1190 = 570 mm.
YK 1191/92 = 595 mm.

COOLING

Cathode socket accelerator electrode	air; q ≈ 0.15 m^3/min, T_i max. 40 °C
Collector	vapour (with boiler TE1110), note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 ℓ/min steam per kW collector dissipation water or vapour condensation (with cooler TE1194) q = 35 to 60 ℓ/min, T_o max 80 °C,
Drift tubes	water; rate of flow to drift tubes and collector connected in series q ≈ 9 ℓ/min, T_i max. 80 °C, Δp = 200 kPa (2 bar)
Cavities 3 and 4	forced air; q = 1.5 m^3/min, Δp = 250 Pa (2.5 mbar) T_i max. 45 °C

MASS AND DIMENSIONS

Klystron			
net	approx.	80	kg
gross	approx.	230	kg
outline dimensions of packing (cm)	205 x 75 x 65		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	885	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3.5 m, excluding hoist, is required.

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

ACCESSORIES (note 5)

A. Accessories required for first equipment

	YK1190	YK1191	YK1192
Collector radiation suppressor	TE1111	TE1132	TE1195
Accelerator electrode ring	TE1141	TE1141	TE1141
Cathode ring	TE1142 or TE1142B	TE1142 or TE1142B	TE1142 or TE1142B
Set of sealing rings, supplied with each tube	TE1147	TE1147	TE1147
Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Extension pipes for drift tubes	6x TE1133A 2x TE1133B	6x TE1133A 2x TE1133B	6x TE1133A 2x TE1133B
Water interconnecting pipes between drift tubes			
$T_2 - T_2$	TE1134A	TE1135A	TE1135A
$T_2 - T_3$	TE1134B	TE1135B	TE1135B
$T_3 - T_4$	TE1134C	TE1135C	TE1135C
$T_4 - T_5$	TE1134D	TE1135D	TE1135D
Flexible water hose between tube and boiler for vapour cooling between frame and tube	TE1145A TE1145B	TE1145A TE1145B	TE1145A TE1145B
Boiler for vapour cooling	TE1110	TE1110	TE1110
or			
Cooler for water cooling	TE1194	TE1194	TE1194
Cavities	3x TE1121A 1x TE1121D	3x TE1098A 1x TE1098D	3x TE1191A 1x TE1191B
Input coupler	TE1122A	TE1102	TE1102
Load coupler for cavities 2 and 3	2x TE1122B	2x TE1102	2x TE1102
Blanking plates	3x TE1157	3x TE1157	3x TE1157
Output coupler for cavity 4	TE1123	TE1105	TE1196
Arc detector	TE1107	TE1107	TE1107
Magnet frame with coils	TE1108	TE1108	TE1108
Tool set	TE1137	TE1137	TE1137

B. Accessories to be ordered separately when replacing equivalent other brand types

	YK1190	YK1191	YK1192
Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146

C. Spare and optional parts	**YK1190**	**YK1191**	**YK1192**
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Set of sealing rings	TE1147	TE1147	TE1147
Water protection shield	TE1139	TE1139	TE1139
Recommended circulators			
470 to 600 MHz	2722 162 01551 (T100/IV-N)		
600 to 800 MHz	2722 162 01561 (T100/V-N)		
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)		

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	23	kV	
Cold cathode voltage	max.	−27	kV	
Beam current	max.	7	A	
Body current	max.	150	mA	
Accelerator electrode current	max.	6	mA	note 7
Collector dissipation	max.	150	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1194B	max.	600	kPa (6 bar)	note 6

TYPICAL OPERATING CONDITIONS: YK1190/YK1191

As 40 kW vision transmitter (standard G)

	gain-tuned operation	efficiency-tuned operation (examples)			
Output power, peak sync.	45	45	45	kW	
Beam voltage	22	20.5	22	kV	
Beam current	6.3	5.7	4.8	A	note 8
Accelerator to cathode voltage	22	20.5	18	kV	
Body current					
without drive	15	15	15	mA	
at 45 kW peak sync., black level	30	40	40	mA	
Focusing coil current	10.5	10.5	10.0	A	
Drive power, peak sync.					
YK1190 - channel 21	2	10	6	W	note 9
channel 38	1.5	7	4	W	note 9
YK1191 - channel 37	1.5	7	4	W	note 9
channel 51	1	5	3	W	note 9
Bandwidth at −1 dB points	8	8	8	MHz	note 10
Differential gain	80	75	70	%	note 11
Differential phase	6	7	10	deg	note 11
Linearity	70	65	60	%	note 12
Operating efficiency	32	38.5	42.5	%	
Saturation output power	55	60	46.5	kW	
Saturation efficiency	40	43	44	%	

As 4 kW/8 kW sound transmitter (standard G)

Output power	4.5	9	4.5	9	kW	
Beam voltage	20.5	20.5	22	22	kV	
Beam current	1.25	1.5	1.15	1.4	A	note 8
Accelerator cathode voltage	≈ 7.5	≈ 8.5	≈ 7	≈ 8	kV	note 13
Focusing coil current	9				A	
Drive power	1.5				W	note 9
Bandwidth at −1 dB points	1				MHz	

TYPICAL OPERATING CONDITIONS: YK1192

As 40 kW vision transmitter (standard G)

Output power, peak sync.	45	kW	
Beam voltage	23	kV	
Beam current	4.6	A	note 8
Accelerator to cathode voltage	18	kV	
Body current			
without drive	15	mA	
at 45 kW peak sync., black level	40	mA	
Focusing coil current	10	A	
Drive power, peak sync.	2	W	note 9
Bandwidth at −1 dB points	8	MHz	note 10
Differential gain	70	%	note 11
Differential phase	10	deg	note 11
Linearity	60	%	note 12
Operating efficiency	42.5	%	
Saturation output power	46.5	kW	
Saturation efficiency	44	%	

As 4 kW/8 kW sound transmitter (standard G)

Output power	4.5	9	kW	
Beam voltage	23	23	kV	
Beam current	1.1	1.3	A	note 8
Accelerator to cathode voltage	≈ 7	≈ 8	kV	note 13
Focusing coil current	9		A	
Drive power	1.5		W	note 9
Bandwidth at −1 dB points	1		MHz	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new waiting time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ·cm).
5. Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used. The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially admissible, non-dangerous level the tube must be shielded and any possible radiation path must be blocked by at least 1 mm of brass or an equivalent portion of non-magnetic X-ray absorbing material. The proper use of our accessory parts will provide the necessary shielding.
6. Static pressure in the body-cooling system and in the water-cooling jacket TE1194.
7. The accelerator electrode voltage must not be positive with respect to the body (ground).
8. If the accelerator electrode is connected to the body (ground) via 10 kΩ resistor, the beam current is within ± 5% of the value given in the graph of Fig. 4.
9. The drive power is defined as the power delivered to a matched load.
10. Variation of the signal level between black and white at any sideband frequency may cause a reaction of the peak sync. level. Proper tube design limits this reaction to less than 0.5 dB.
11. Measured with a sawtooth signal from black level to peak white occuring at each line and superimposed colour subcarrier with a 10 % peak to peak amplitude.
12. Measured with a ten-step staircase signal from black level to peak with occuring at each line.
13. A voltage divider for adjusting the beam current should be dimensioned on the basis of an accelerator electrode current of max. 1.5 mA.

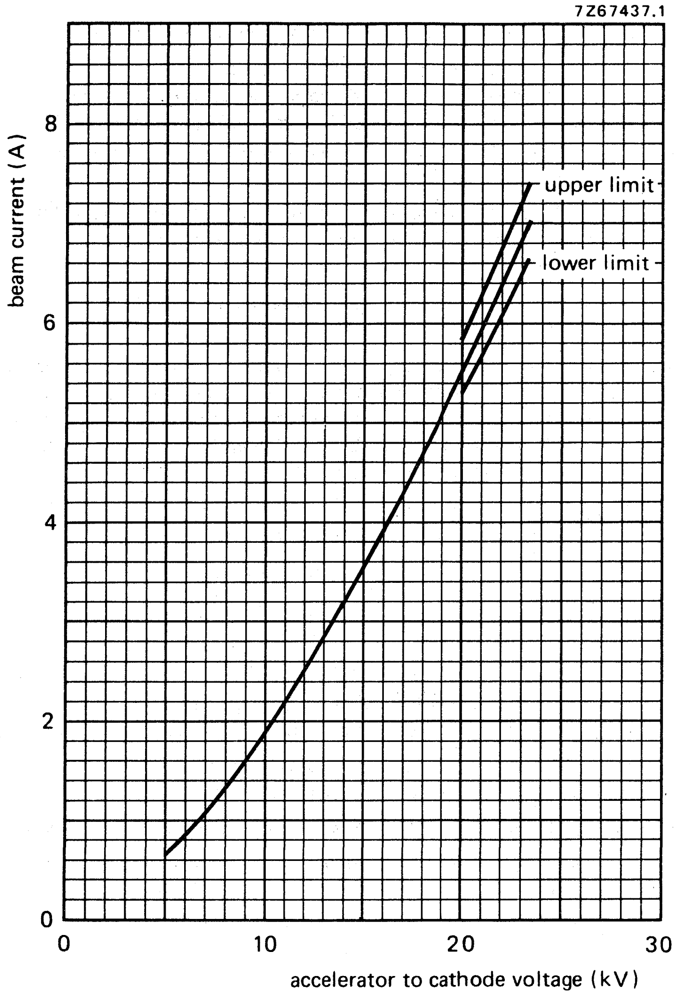

7Z67437.1
beam current (A)
8
6
4
2
0
upper limit
lower limit
0
10
20
30
accelerator to cathode voltage (kV)

Fig. 4.

U.H.F. POWER KLYSTRON

Optionally vapour, vapour condensation, or water-cooled power klystron in metal-ceramic construction for 60 kW CW amplifiers. The tube has four external cavities, electromagnetic focusing and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Frequency range	800 MHz
Cooling	vapour, vapour condensation, or water

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

					notes
HEATING: indirect by d.c.					
Cathode	dispenser type				
Heater voltage	V_f	≈	8.5	V ±3 %	
Heater current	I_f	≈	22 to 27	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	
FOCUSING: electromagnetic					
Focusing coil current			9 to 12	A	
Resistance of focusing coils					
cold (20 °C)			7.2 to 9.5	Ω	
operating at an ambient temperature of 20 °C		⩽	11	Ω	

BEAM CONTROL

The accelerator electrode voltage allows adjustment of the beam current between 0 and 100%.

			notes
ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

MECHANICAL DATA

Dimensions in mm

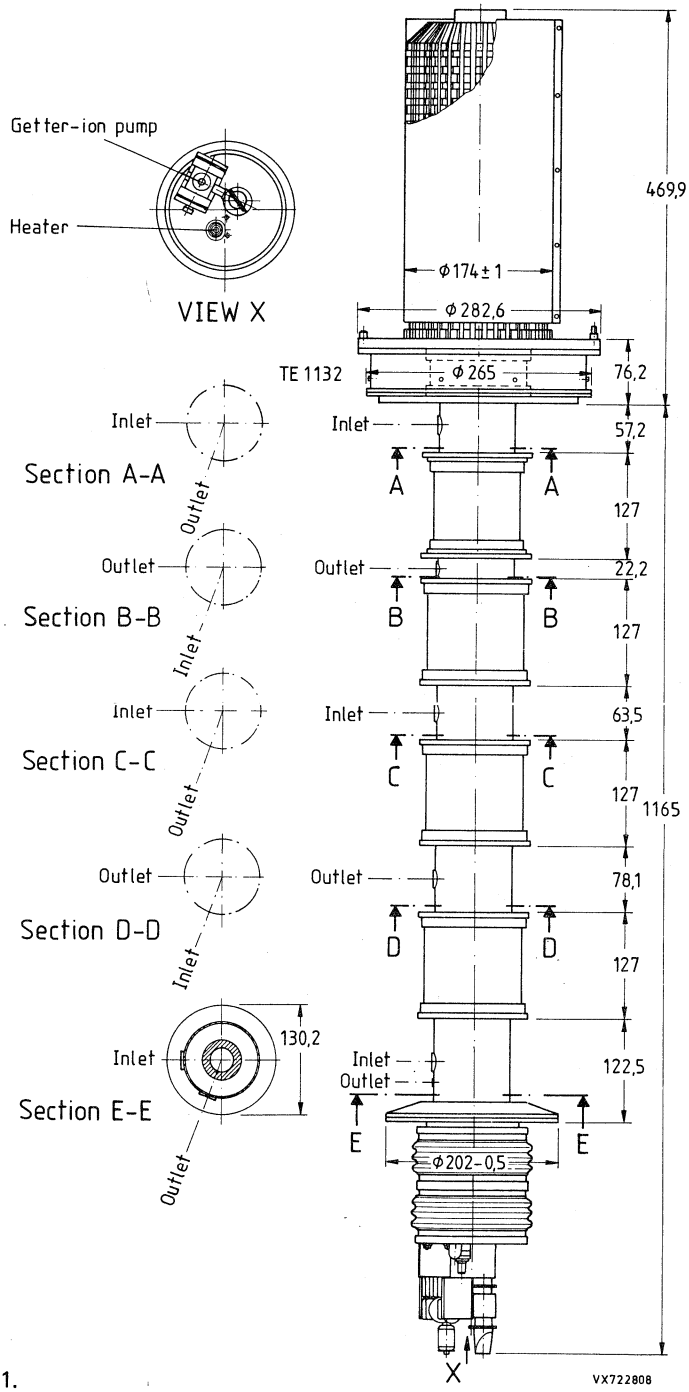


Fig. 1.

Mechanical outlines of trolley

Dimensions in mm

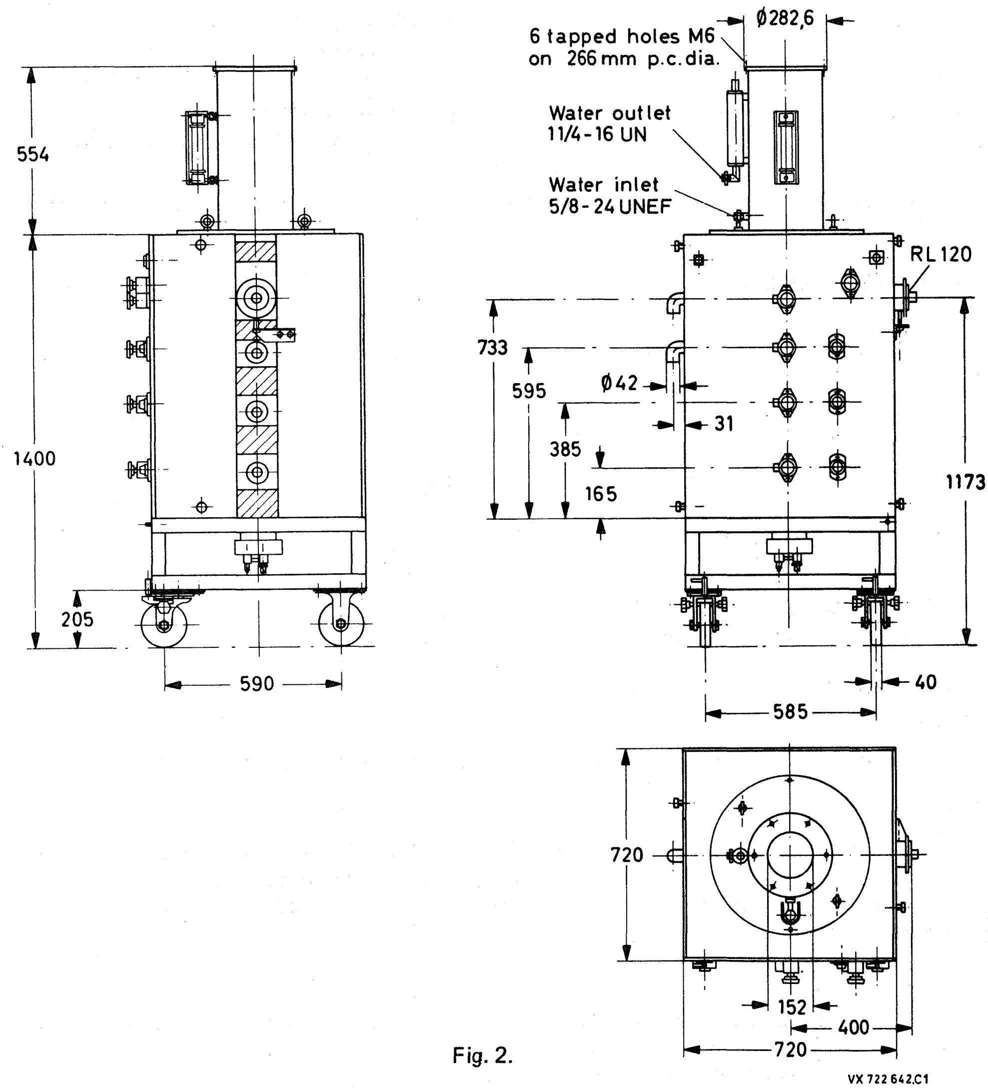


Fig. 2.

COOLING

Cathode socket accelerator electrode	air; q ≈ 0.15 m^3/min, T_i max. 40 °C
Collector	vapour (with boiler TE1110), note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 ℓ/min steam per kW collector dissipation water or vapour condensation (with cooler TE1194) q = 35 to 60 ℓ/min, T_o max 80 °C,
Drift tubes	water; rate of flow to drift tubes and collector connected in series q ≈ 9 ℓ/min, T_i max. 80 °C, Δp = 200 kPa (2 bar)
Cavities 3 and 4	forced air; q = 1.5 m^3/min, Δp = 250 Pa (2.5 mbar) T_i max. 45 °C

MASS AND DIMENSIONS

Klystron			
net	approx.	80	kg
gross	approx.	230	kg
outline dimensions of packing (cm)	205 x 75 x 65		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	885	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3.5 m, excluding hoist, is required.

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

ACCESSORIES

Set of sealing rings	TE1147	
Collector radiation suppressor	TE1195	
Accelerator electrode ring	TE1141	
Cathode ring	TE1142	
Water interconnecting pipes between drift tubes		
T_1 - T_2	TE1135A	
T_2 - T_3	TE1135B	
T_3 - T_4	TE1135C	
T_4 - T_5	TE1135D	
Extension pipes for drift tubes	6 x TE1133A 2 x TE1133B	
Flexible water pipes	for vapour cooling	for water cooling
between tube and boiler	TE1145A	–
between frame and tube	TE1145B	TE1145B
tube outlet	–	TE1145C
Boiler for vapour cooling	TE1110	–
or		
Cooler for water cooling	–	TE1194
Magnet flux ring	TE1138	
Water protection shield	TE1139	
Spark gap	TE1140	
Set of connectors (heater, cathode, accelerator electrode, getter-ion pump)	TE1146	
Cavities	3 x TE1191A 1 x TE1191B	
Input coupler	TE1102	
Load coupler for cavities 2 and 3	2 x TE1102	
Blind flanges	3 x TE1157	
Output coupler for cavity 4	TE1192	
Arc detector	TE1107	
Magnet frame with coils	TE1193	
Tool set	TE1137	
Recommended circulator	2722 162 01561 (T100/V-N)	

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	28	kV	
Cold cathode voltage	max.	−30	kV	
Beam current	max.	7	A	
Body current	max.	60	mA	
Accelerator electrode current	max.	6	mA	note 5
Collector dissipation	max.	150	kW	
Load VSWR	max.	1.5		
Temperature of envelope	max.	175	°C	
Static pressure in the body cooling system and in the water cooling jacket TE1194	max.	600	kPa	(6 bar)

TYPICAL OPERATING CONDITIONS

As 60 kW CW amplifier

Output power		60	kW	
Beam voltage		27	kV	
Beam current		4.9	A	note 6
Accelerator to cathode voltage	≈	17	kV	
Body current				
without drive		10	mA	
at 60 kW		20	mA	
Focusing coil current	≈	10	A	
Drive power, at 800 MHz	≈	2	W	note 7
Bandwidth at −1 dB points	≈	5	MHz	
Operating efficiency	=	45	%	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new waiting time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ·cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. If the accelerator electrode is connected to the body (ground) via 10 kΩ resistor, the beam current is within ± 5% of the value given in the graph of Fig. 3.
7. The drive power is defined as the power delivered to a matched load.

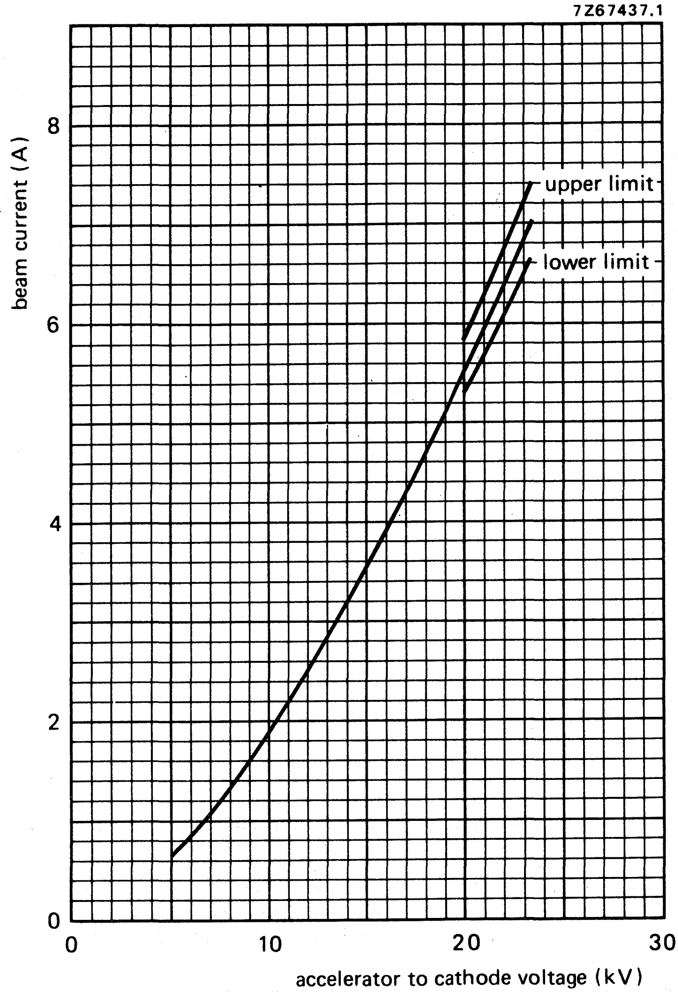

7Z67437.1
beam current (A)
8
6
4
2
0
0
10
20
30
accelerator to cathode voltage (kV)
upper limit
lower limit

Fig. 3.

UHF POWER KLYSTRONS

For UHF band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
YK 1223 comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860 MHz
Output power as vision transmitter	10 and 15 kW
Cooling	vapour, vapour condensation, or water

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

					notes
HEATING: indirect by DC					
Cathode	dispenser type				
Heater voltage	V_f		4.8	V *	
Heater current	I_f	≈	19.5 to 22.5	A	1
Cold heater resistance	R_{fo}	≈	25	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 4.3$ to 4.5 V	t_w	min.	0	s	
FOCUSING					
Focusing coil current			8.5 to 11	A	
Resistance of focusing coils					
cold (20 °C)			7.2 to 9.5	Ω	
operating at an ambient temperature of 20 °C		≤	11	Ω	

BEAM CONTROL for YK 1220 — notes 6, 7

The accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

BEAM CONTROL for YK 1223 — notes 6, 7

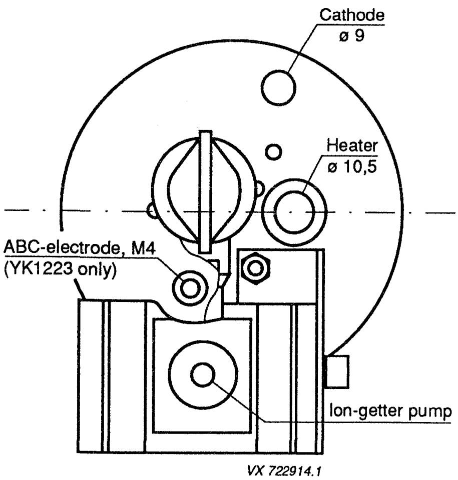
The klystron comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 6.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

			notes
ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

* The tube must be operated with $V_f = 5.3$ V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or –2%.

MECHANICAL DATA

Dimensions in mm



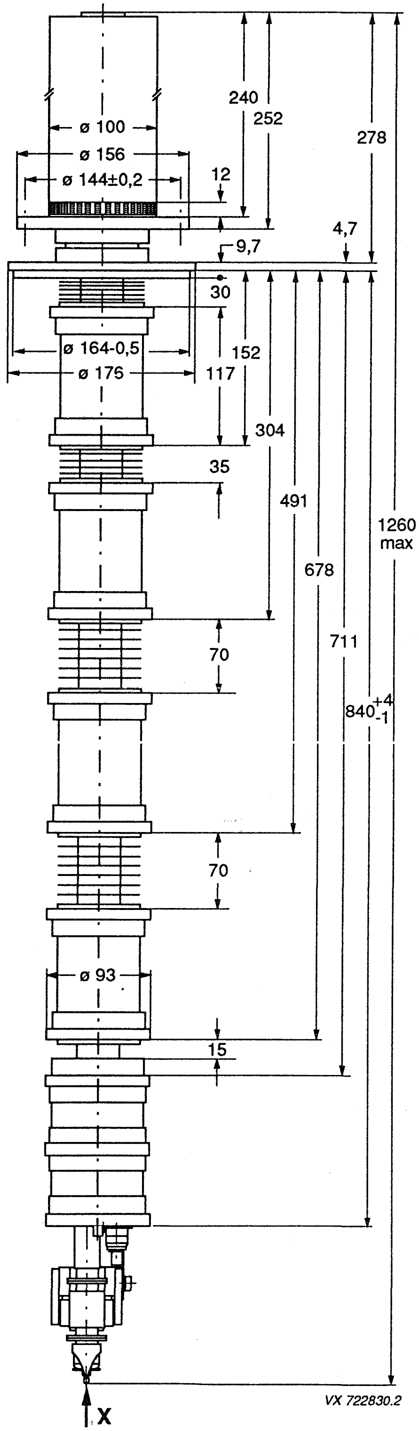


Fig. 1. VIEW X

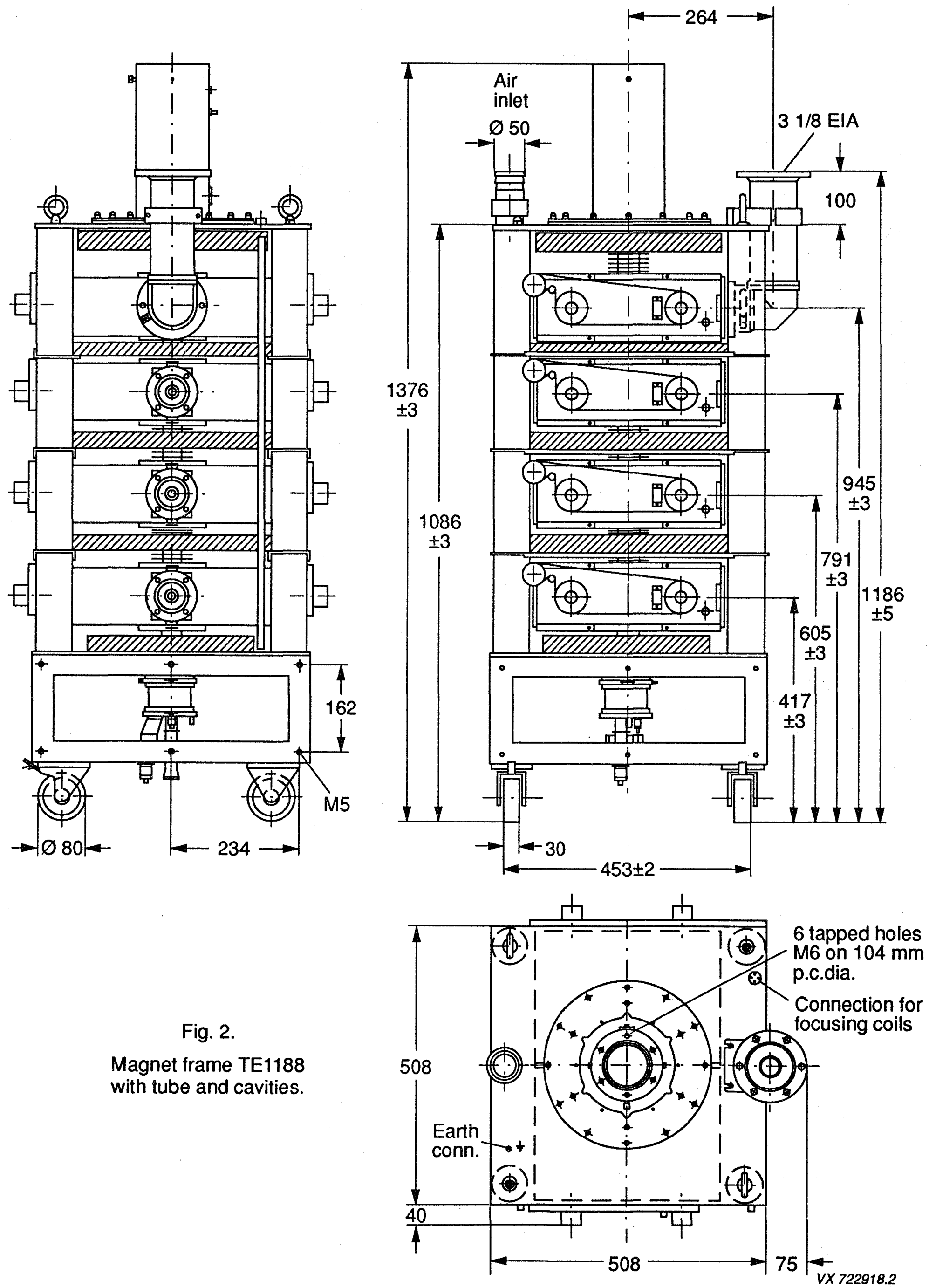


Fig. 2.

Magnet frame TE1188
with tube and cavities.

MASS AND DIMENSIONS

Klystron			
net	approx.	25	kg
gross	approx.	79	kg
outline dimensions of packing (cm)	170 x 45 x 46		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	220	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 2.5 m, excluding hoist, is required.

COOLING

Cavities 1, 2, 3 and 4, drift tubes 4 and 5 and cathode socket	forced air, T_i max. 50 °C, $q \approx 1.2$ m^3/min, $\Delta p = 350$ Pa (3.5 mbar)
Cathode socket only, during black heat	forced air, T_i max. 50 °C, $q \approx 0.15$ m^3/min
Collector	vapour with boiler TE1189C, note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 l/min steam per kW collector dissipation; water or vapour condensation (with water jacket TE1189A) q = 7 to 18 l/min, T_o max 90 °C, see Fig. 4. For 10 l/min, $\Delta p = 16$ kPa (0.16 bar)

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1188	
Collector radiation suppressor	TE1182 B	
Collector jacket for water or vapour condensation cooling	TE1189A	
Boiler for vapour cooling	TE1189C	
Temperature sensor	TE1199	note 11
Spark gap	TE1183	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1184	
Cavities, continuously tunable	4 x TE1285	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	2 x TE1107C	note 12
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1186F	
Output coupler, 3 1/8 inch, 90° elbow	TE1187C	note 13, 14
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1188 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	6.5	V	
Beam voltage	max.	21	kV	
Cold cathode voltage	max.	–21	kV	
Beam current	max.	3	A	
Body current RF on	max.	100	mA	
Accelerator electrode current	max.	5	mA	note 5
Collector dissipation	max.	42	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1189A	max.	600	kPa (6 bar)	
Focusing coil current	min.	8.5	A	
	max.	11.5	A	
ABC-electrode voltage with respect to cathode	max.	–1	kV	

PERFORMANCE DATA

of ABC-electrode for YK1223	min.	typ.	max.	
Capacity	70	75	85	pF
DC current at –1000 V *	-	-	0.5	mA

* The DC electrode current may rise up to max. 1 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 1 mA.

TYPICAL OPERATING CONDITIONS (ABC electrode YK1223 at cathode potential)

As 10 kW vision transmitter

								notes
Standard:	G	I	G	I	G	I		10
Channel	21		45		68			
Output power, peak sync.	11		11		11		kW	
Beam voltage	13	13.5	15	15	16	16	kV	
Beam current	1.95	2.05	1.55	1.55	1.5	1.5	A	6
Accelerator to cathode voltage	≈ 12	≈ 12.5	≈ 10	≈ 10	≈ 10	≈ 10	kV	7
Body current								
without drive	≈ 10	≈ 10	≈ 7	≈ 7	≈ 7	≈ 7	mA	
at black level	≈ 50	≈ 50	≈ 35	≈ 35	≈ 30	≈ 30	mA	
Focusing coil current	≈ 10	≈ 10	≈ 9	≈ 9	≈ 9	≈ 9	A	
Drive power, peak sync. max.	10	15	6	10	4	8	W	8
Operating efficiency	43	40	47	47	45	45	%	
Minimum efficiency	42	40	46	44	44	43	%	

Sound transmitter

Output power	1.1		2.2		5.5	kW	
Beam voltage	13	16	13	16	18.5	kV	
Beam current	0.38	0.3	0.5	0.4	0.8	A	6
Accelerator to cathode voltage	≈ 3.5	≈ 3.0	≈ 4.5	≈ 3.5	≈ 6.0	kV	7
Body current	≈ 15		≈ 15		≈ 15	mA	
Focusing coil current	≈ 10		≈ 10		≈ 10	A	9
Drive power,							
channel 21	4		4		4	W	8
channel 45	2		2		2	W	8
channel 68	1		1		1	W	8
Bandwidth at −1 dB points	≥ 300		≥ 300		≥ 300	kHz	
Operating efficiency	22		34		37	%	

TYPICAL OPERATING CONDITIONS (continued)
(ABC electrode YK1223 at cathode potential)

As 15 kW vision transmitter

								notes
Standard:	G	I	G	I	G	I		10
Channel	21		45		68			
Output power, peak sync.	16.5		16.5		16.5		kW	
Beam voltage	16.5	15.5	17.5	17.5	19	19	kV	
Beam current	2.35	2.6	2.0	2.0	1.95	1.95	A	6
Accelerator to cathode voltage	≈ 13.5	≈ 14.5	≈ 12	≈ 12	≈ 12	≈ 12	kV	7
Body current								
without drive	≈ 10	≈ 10	≈ 7	≈ 7	≈ 7	≈ 7	mA	
at black level	≈ 50	≈ 70	≈ 45	≈ 45	≈ 40	≈ 40	mA	
Focusing coil current	≈ 10	≈ 10	≈ 9	≈ 9	≈ 9	≈ 8.5	A	
Drive power, peak sync. max.	10	15	8	10	6	10	W	8
Operating efficiency	43	43	47	47	45	45	%	
Minimum efficiency	42	40	46	44	44	43	%	

Sound transmitter

Output power	1.65		3.3		kW	
Beam voltage	15.5	19	15.5	19	kV	
Beam current	0.37	0.3	0.63	0.5	A	6
Accelerator to cathode voltage	≈ 3.5	≈ 3.0	≈ 4.5	≈ 4.5	kV	7
Body current	≈ 15		≈ 15		mA	
Focusing coil current	≈ 10		≈ 10		A	9
Drive power,						
channel 21	4		4		W	8
channel 45	2		2		W	8
channel 68	1		1		W	8
Bandwidth at −1 dB points	≥ 300		≥ 300		kHz	
Operating efficiency	29		34		%	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 4.3 to 4.5 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ · cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For cathode current versus accelerator-to-cathode voltage, see Fig. 5.
7. The accelerator electrode has to be connected to its supply (power supply or voltage divider) via a 10 kΩ resistor.
   For adjusting the cathode current a voltage divider should be dimensioned according to an accelerator electrode current of max. 1.5 mA.
8. The drive power is defined as the power delivered to a matched load.
9. Value is not critical. It may be set in accordance to the vision klystron focusing coil current. Operation of one vision and one sound klystron focusing unit in series is admitted.
10. Standard I: klystron tuned to frequency response according Fig. 3.

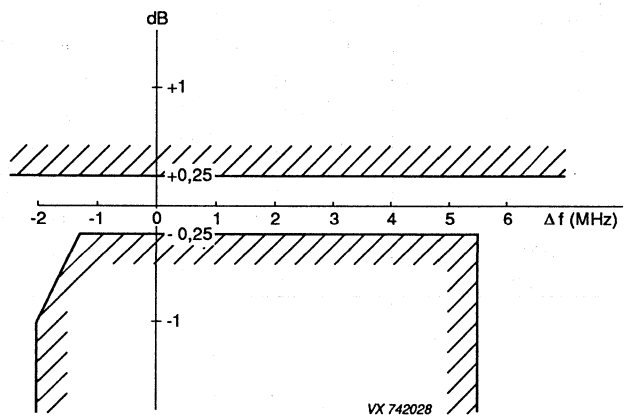


Fig. 3.

11. Optional for water or vapour-condensation cooling.
12. In any case cavity 4 must be equipped with an arc detector. It is recommended to equip also the penultimate cavity (position 3) with an arc detector when the klystron is operated with an output power ≥ 15 kW (vision), ≥ 8 kW (sound).
13. The output couplers TE1187 comprise a standard loop (Type No 1). For certain channels special (optional) coupling loops are required.

TE1187R (Type No 2)	for vision/sound operation at channel 32/31 (8 MHz raster) resp. 28, 29/28 (6 MHz raster)
TE1187S (Type No 3)	for operation above channel 62 (8 MHz raster) resp. 68 (6 MHz raster)

14. For output power ≤ 10 kW output couplers 1 5/8 inch (TE1187A for front panel control or TE1187B for direct control) are also available.

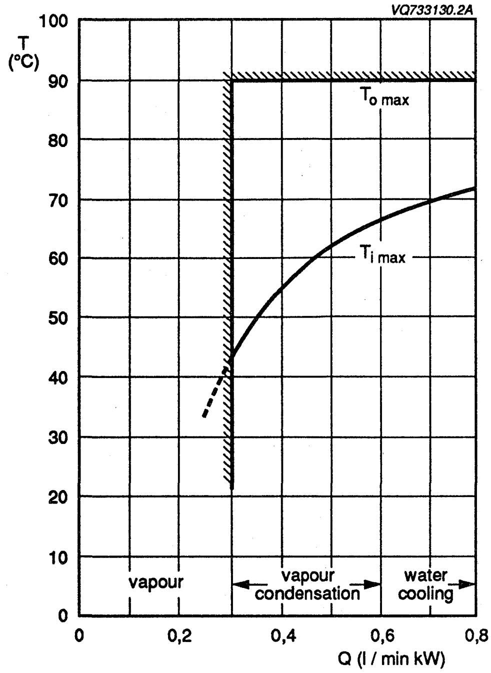


Fig. 4.

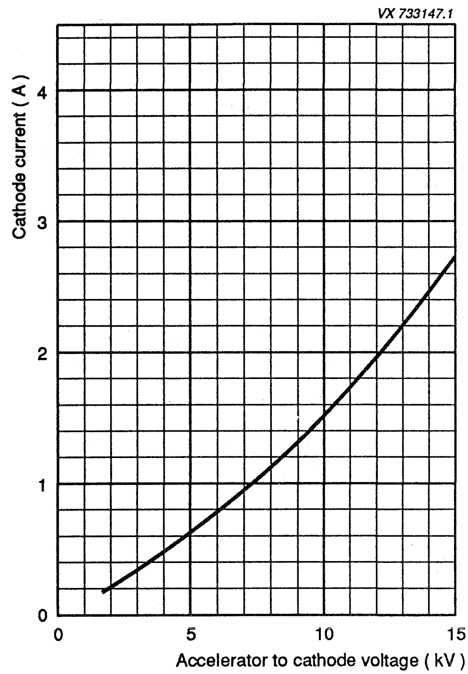


Fig. 5.

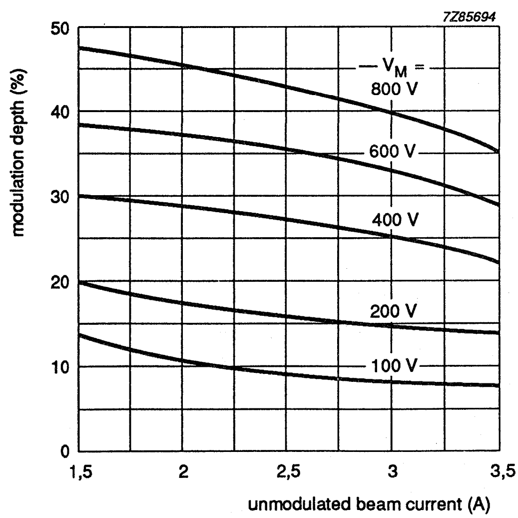


Fig. 6. ABC-operation for YK1223
Parameter: modulation voltage $-V_M$
(with respect to cathode).

UHF POWER SOUND KLYSTRON

For UHF band IV/V sound transmitters, in combination with klystron types YK1220/23, YK1230/33/34/35 and YK1263/65 in vision transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860 MHz
Output power	7.5 kW
Cooling	vapour, vapour condensation, or water

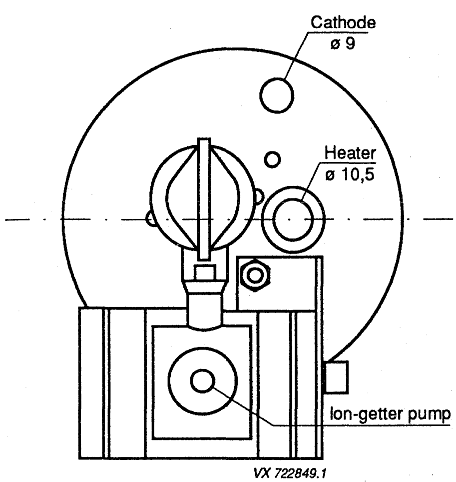
This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

					notes
HEATING: indirect by DC					
Cathode	dispenser type				
Heater voltage	V_f		4.8	V *	
Heater current	I_f	≈	19.5 to 22.5	A	1
Cold heater resistance	R_{fo}	≈	25	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 4.3$ to 4.5 V	t_w	min.	0	s	
FOCUSING					
Focusing coil current			8.5 to 11	A	
Resistance of focusing coils					
cold (20 °C)			7.2 to 9.5	Ω	
operating at an ambient temperature of 20 °C		≤	11	Ω	
BEAM CONTROL for YK 1220					6, 7
The accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.					
ION-GETTER PUMP SUPPLY					3
Pump voltage, no-load condition			3 to 4	kV	
Internal resistance of supply			300	kΩ	

* The tube must be operated with $V_f = 5.3$ V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or −2%.

MECHANICAL DATA

Dimensions in mm



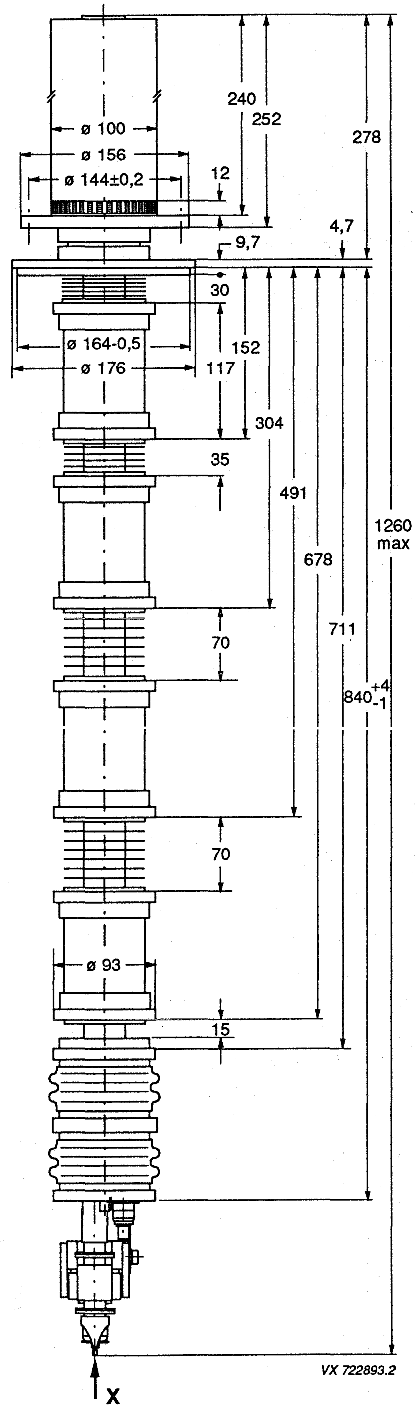


Fig. 1. VIEW X

DEVELOPMENT DATA

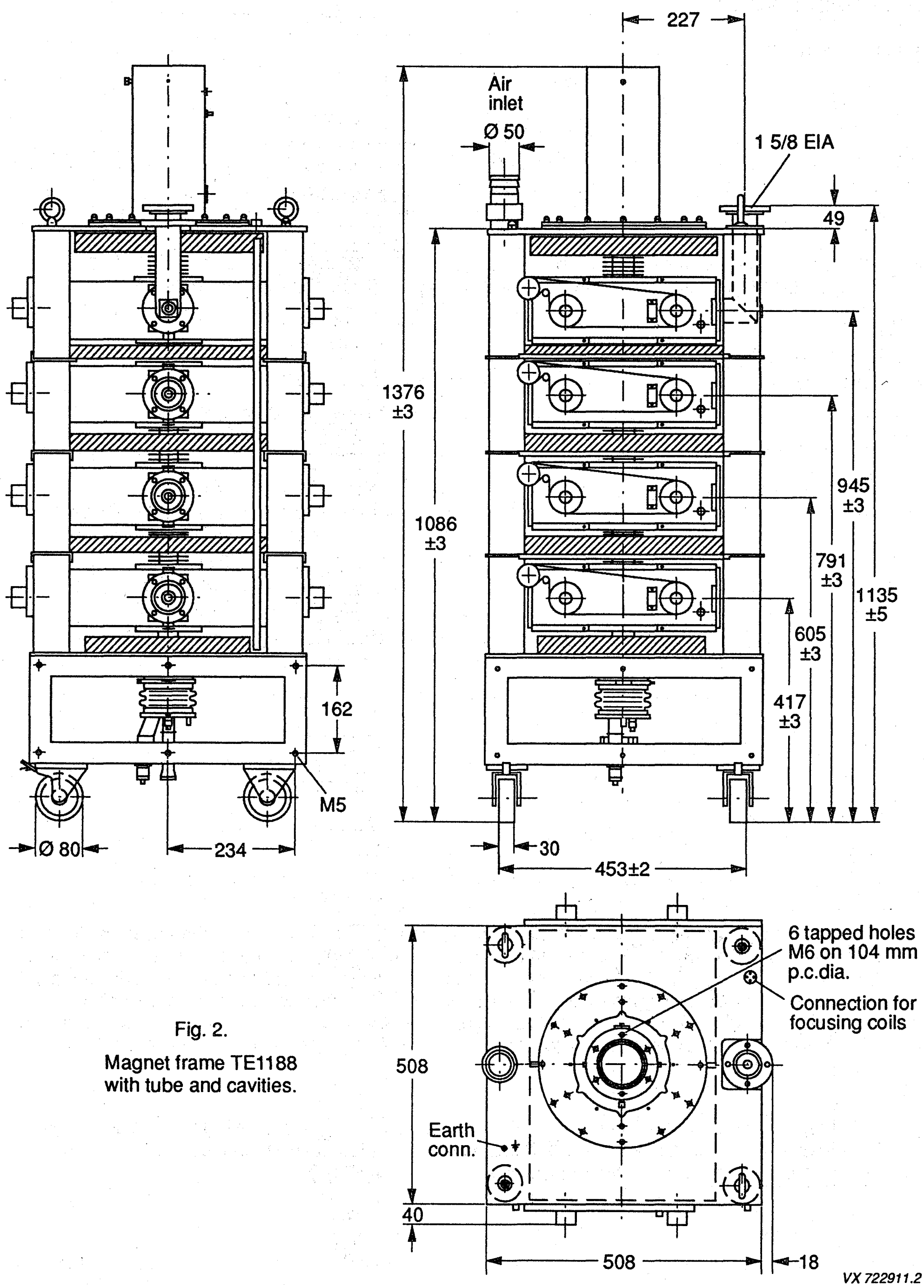


Fig. 2.

Magnet frame TE1188
with tube and cavities.

MASS AND DIMENSIONS

Klystron			
net	approx.	25	kg
gross	approx.	79	kg
outline dimensions of packing (cm)	170 x 45 x 46		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	220	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 2.5 m, excluding hoist, is required.

COOLING

Cavities 1, 2, 3 and 4, drift tubes 4 and 5 and cathode socket	forced air, T_i max. 50 °C, $q \approx 1.2\ m^3/min$, $\Delta p = 350$ Pa (3.5 mbar)
Cathode socket only, during black heat	forced air, T_i max. 50 °C, $q \approx 0.15\ m^3/min$
Collector	vapour with boiler TE1189C, note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 l/min steam per kW collector dissipation; water or vapour condensation (with water jacket TE1189A) q = 7 to 18 l/min, T_o max 90 °C, see Fig. 3. For 10 l/min, Δp = 16 kPa (0.16 bar)

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1188 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

DEVELOPMENT DATA

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1188	
Collector radiation suppressor	TE1182 B	
Collector jacket for water or vapour condensation cooling	TE1189A	
Boiler for vapour cooling	TE1189C	
Temperature sensor	TE1199	note 10
Spark gap	TE1183	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1184	
Cavities, continuously tunable	4 x TE1285	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	TE1107C	note 11
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1186F	
Output coupler, 1 5/8 inch, 90° elbow	TE1187B	note 12, 13
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	6.5	V	
Beam voltage	max.	28	kV	
Cold cathode voltage	max.	−30	kV	
Beam current	max.	3	A	
Body current RF on	max.	100	mA	
Accelerator electrode current	max.	5	mA	note 5
Collector dissipation	max.	42	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1189A	max.	600	kPa (6 bar)	
Focusing coil current	max.	11.5	A	
	min.	8.5	A	

TYPICAL OPERATING CONDITIONS

As sound transmitter in combination with

	YK1265			YK1263				notes
Vision power		64			45		kW	
Vision / sound ratio		10 : 1			10 : 1			
Sound power		7.5			5		kW	
Channel	21	42	62	21	42	62		
Beam voltage	25	26	27	21	22.5	24.5	kV	
Beam current		t.b.d.			t.b.d.		A	6
Accelerator to cathode voltage		t.b.d.			t.b.d.		kV	7
Body current	≈20	≈20	≈20	≈15	≈15	≈15	mA	
Focusing coil current	≈10	≈9.5	≈9	≈10	≈9.5	≈9	A	
Drive power		t.b.d.			t.b.d.		W	8
Maximum efficiency		t.b.d.			t.b.d.		%	
Bandwidth at -1 dB points	2	2	2	2	2	2	MHz	

As sound transmitter in combination with

	YK1230/33			YK1230/33			YK1230/33				
Vision power		27			22			33		kW	
Vision / sound ratio		5 : 1			5 : 1			10 : 1			
Sound power		6.3			5.0			3.8		kW	
Channel	21	42	62	21	42	62	21	42	62		
Beam voltage	19	21.5	23.5	19.5	20	22	23	24	25	kV	
Beam current		t.b.d.			t.b.d.			t.b.d.		A	6
Accelerator to cathode voltage		t.b.d.			t.b.d.			t.b.d.		kV	7
Body current	≈15	≈15	≈15	≈15	≈15	≈15	≈15	≈15	≈15	mA	
Focusing coil current	≈10	≈10	≈10	≈10	≈10	≈10	≈8.5	≈8.5	≈8.5	A	
Drive power		t.b.d.			t.b.d.			t.b.d.		W	8
Maximum efficiency		t.b.d.			t.b.d.			t.b.d.		%	
Bandwidth at -1 dB points	2	2	2	2	2	2	2	2	2	MHz	

As sound transmitter in combination with

	YK1230/33			YK1230/33				notes
Vision power		22			11		kW	
Vision / sound ratio		10 : 1			10 : 1			
Sound power		2.5			1.25		kW	
Channel	21	42	62	21	42	62		
Beam voltage	19.5	20	22	13	15	16	kV	
Beam current		t.b.d.			t.b.d.			6
Accelerator to cathode voltage		t.b.d.			t.b.d.		kV	7
Body current	≈15	≈15	≈15	≈15	≈15	≈15	mA	
Focusing coil current	≈10	≈10	≈10	≈10	≈10	≈10	A	
Drive power		t.b.d.			t.b.d.		W	8
Maximum efficiency		t.b.d.			t.b.d.		%	
Bandwidth at -1 dB points	2	2	2	2	2	2	MHz	

DEVELOPMENT DATA

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 4.3 to 4.5 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ · cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For cathode current versus accelerator-to-cathode voltage, see Fig. 4.
7. The accelerator electrode has to be connected to its supply (power supply or voltage divider) via a 10 kΩ resistor.
   For adjusting the cathode current a voltage divider should be dimensioned according to an accelerator electrode current of max. 1.5 mA.
8. The drive power is defined as the power delivered to a matched load.
9. Value is not critical. It may be set in accordance to the vision klystron focusing coil current. Operation of one vision and one sound klystron focusing unit in series is admitted.
10. Optional.
11. In any case cavity 4 must be equipped with an arc detector.

11. In any case cavity 4 must be equipped with an arc detector.
12. Output coupler for front panel control TE1187A, 1 5/8 inch and output coupler for direct control TE1187C 3 1/8 inch are also available.
13. The output couplers TE1187 comprise a standard loop (Type No 1). For certain channels special (optional) coupling loops are required.

TE1187R (Type No 2)	for vision/sound operation at channel 32/31 (8 MHz raster) resp. 28, 29/28 (6 MHz raster)
TE1187S (Type No 3)	for operation above channel 62 (8 MHz raster) resp. 68 (6 MHz raster)

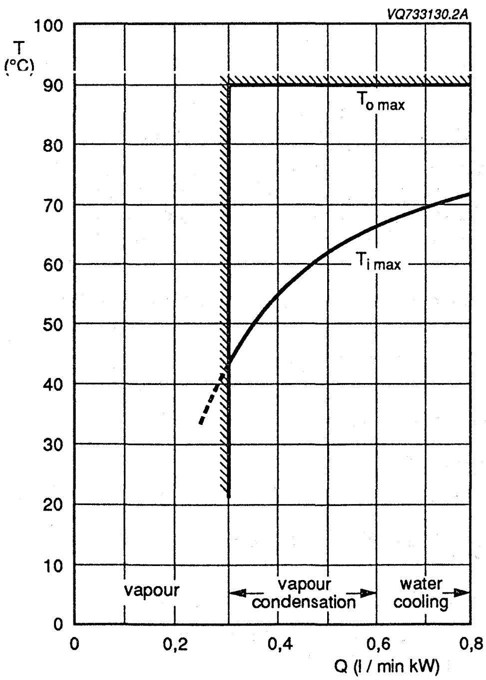


Fig. 3.

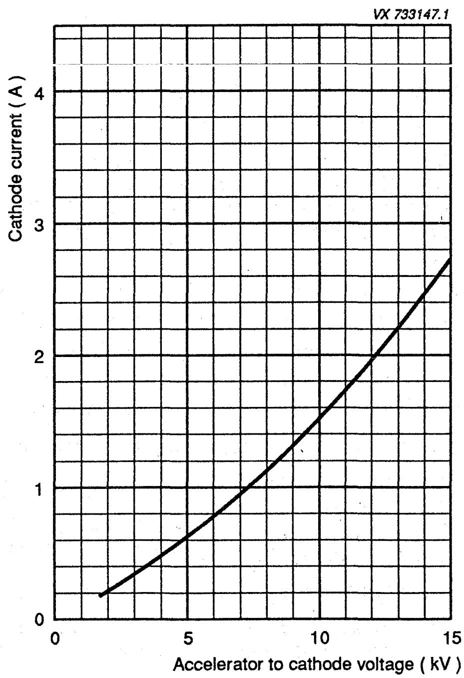


Fig. 4.

UHF POWER KLYSTRONS

For UHF band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
YK 1233 and YK1235 comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860 MHz
Output power as vision transmitter	
YK1230, YK1233	20 and 25 kW
YK1234, YK1235	25 and 30 kW
Cooling	vapour, vapour condensation, or water

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

					notes
HEATING: indirect by DC					
Cathode	dispenser type				
Heater voltage	V_f		4.8	V *	
Heater current	I_f	≈	19 to 22	A	1
Cold heater resistance	R_{fo}	≈	25	mΩ	
Preheating time					2
from cold, V_f = 0 V	t_w	min.	300	s	
from black heat, V_f = 4.3 to 4.5 V	t_w	min.	0	s	
FOCUSING					
Focusing coil current			8.5 to 11	A	
Resistance of focusing coils					
cold (20 °C)			7.2 to 9.5	Ω	
operating at an ambient temperature of 20 °C		≤	11	Ω	

BEAM CONTROL for YK 1230 and YK1234 — notes 6, 7
The accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

BEAM CONTROL for YK 1233 and YK1235 — notes 6, 7
The klystrons comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 6.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

			notes
ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

* The tube must be operated with V_f = 5.3 V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or –2%.

MECHANICAL DATA

Dimensions in mm

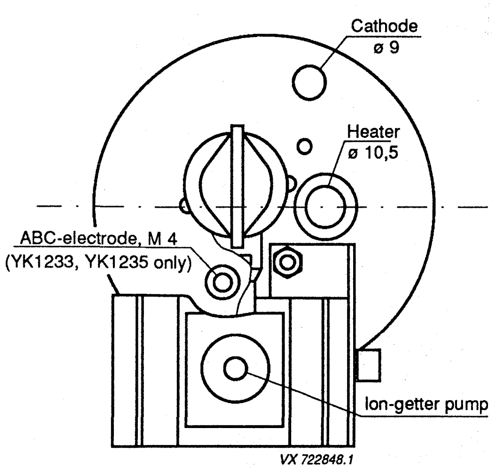
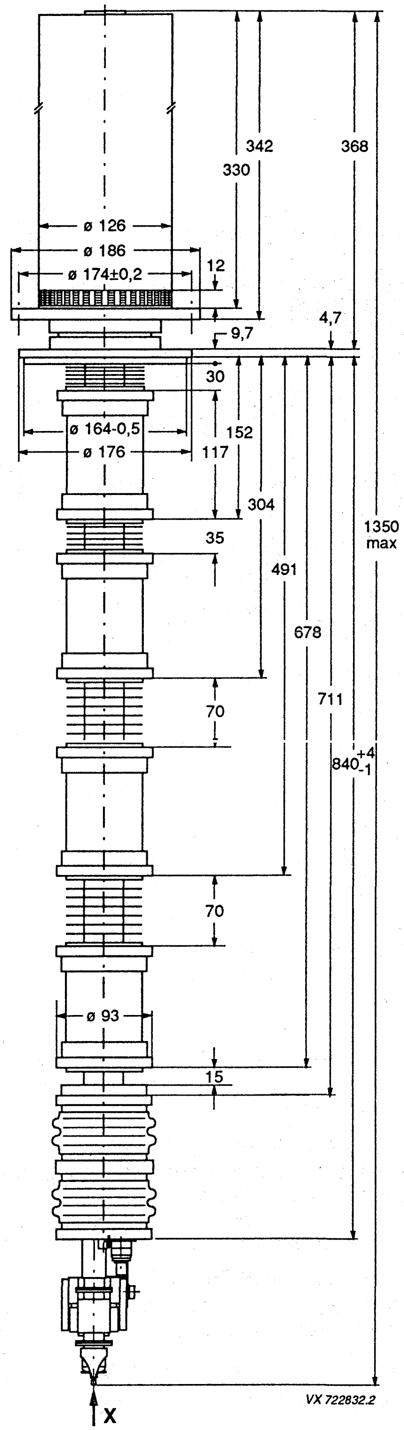


Fig. 1. VIEW X



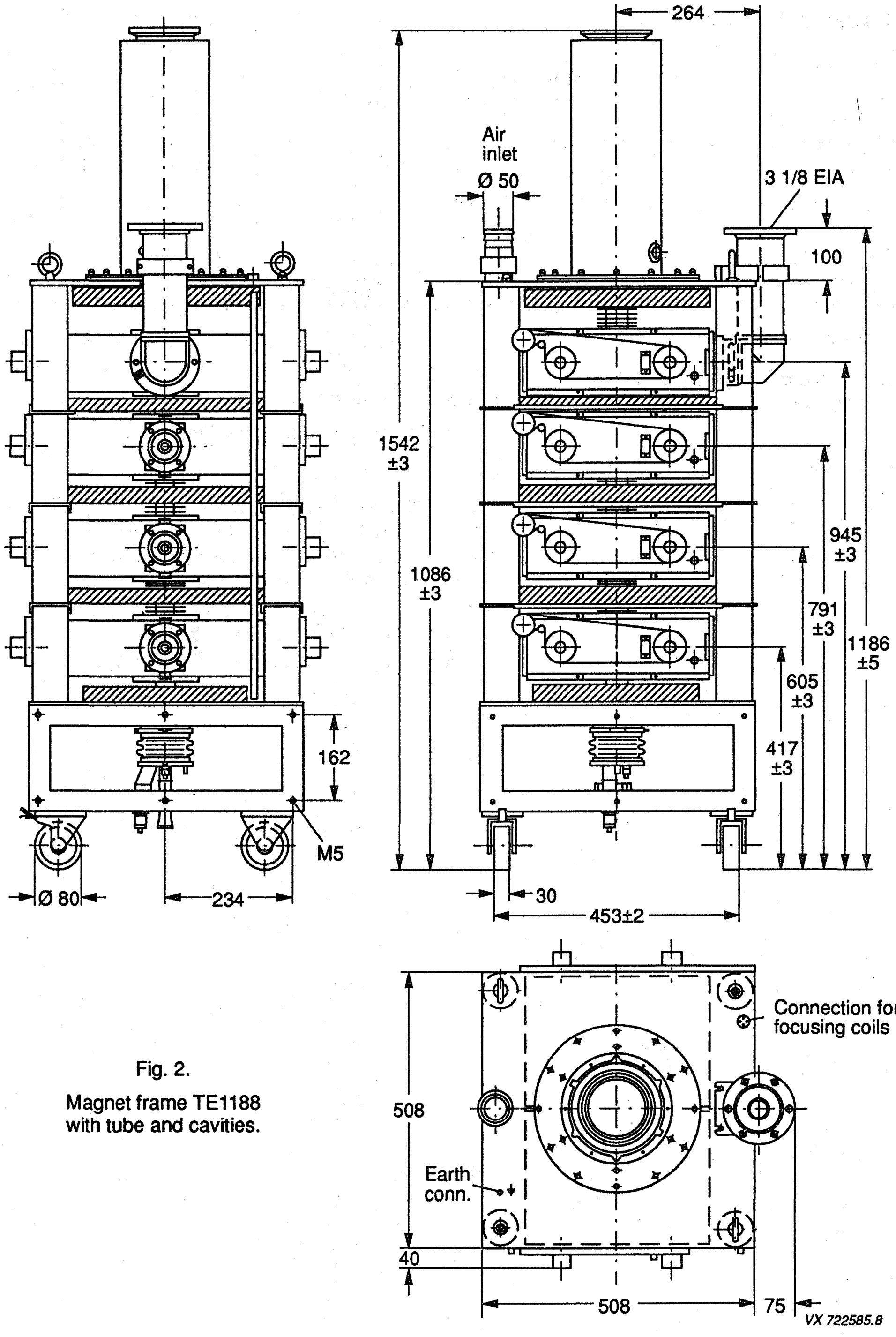


Fig. 2.

Magnet frame TE1188
with tube and cavities.

MASS AND DIMENSIONS

Klystron			
net	approx.	40	kg
gross	approx.	92	kg
outline dimensions of packing (cm)	170 x 45 x 46		
Cavities	approx.	64	kg
Magnet frame with coils	approx.	230	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 2.5 m, excluding hoist, is required.

COOLING

Cavities 1, 2, 3 and 4, drift tubes 4 and 5 and cathode socket	forced air, T_i max. 50 °C, $q \approx 1.2\ m^3/min$, $\Delta p = 350$ Pa (3.5 mbar)
Cathode socket only, during black heat	forced air, T_i max. 50 °C, $q \approx 0.15\ m^3/min$
Collector	vapour with boiler TE1189D, note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 l/min steam per kW collector dissipation; water or vapour condensation (with water jacket TE1189G) q = 16 to 36 l/min, T_o max 90 °C, see Fig. 4. For 10 l/min, Δp = 16 kPa (0.16 bar)

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1188	
Collector radiation suppressor	TE1182 B	
Collector jacket for water or vapour condensation cooling	TE1189G	
Boiler for vapour cooling	TE1189D	
Temperature sensor	TE1199	note 11
Spark gap	TE1183	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1184	
Cavities, continuously tunable	4 x TE1285	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	2 x TE1107C	note 13
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1186F	
Output coupler, 3 1/8 inch, 90° elbow	TE1187C	note 12
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1188 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	6.5	V	
Beam voltage	max.	26	kV	
Cold cathode voltage	max.	–26	kV	
Beam current	max.	3.8	A	
Body current RF on	max.	120	mA	
Accelerator electrode current	max.	5	mA	note 5
Collector dissipation				
YK1230, YK1233	max.	70	kW	
YK1234, YK1235	max.	80	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1189G	max.	600	kPa (6 bar)	
Focusing coil current	min.	8.5	A	
	max.	11.5	A	
ABC-electrode voltage with respect to cathode for YK1233, YK1235	max.	–1	kV	

PERFORMANCE DATA

of ABC-electrode for YK1233, YK1235	min.	typ.	max.	
Capacity	70	75	85	pF
DC current at –1000 V *	-	-	0.5	mA

* The DC electrode current may rise up to max. 1 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 1 mA.

TYPICAL OPERATING CONDITIONS (ABC electrode YK1233 at cathode potential)

As 20 kW vision transmitter (YK1230, YK1233)

					notes
Standard G					10
Channel	21	45	68		
Output power, peak sync.	22	22	22	kW	
Beam voltage	19.5	20	22	kV	
Beam current	2.7	2.45	2.2	A	6
Accelerator to cathode voltage	≈ 15	≈ 14	≈ 13	kV	7
Body current					
without drive	≈ 10	≈ 7	≈ 7	mA	
at black level	≈ 50	≈ 45	≈ 40	mA	
Focusing coil current	≈ 10	≈ 9	≈ 9	A	
Drive power, peak sync. max.	15	10	10	W	8
Operating efficiency	42	45	45	%	
Minimum efficiency	41	44	44	%	

Sound transmitter

Output power	2.2		4.4		kW	
Beam voltage	19.5	22	19.5	22	kV	
Beam current	0.4	0.35	0.6	0.55	A	6
Accelerator to cathode voltage	≈ 3.5	≈ 3.0	≈ 5.0	≈ 4.5	kV	7
Body current	≈ 15		≈ 15		mA	
Focusing coil current	≈ 10		≈ 10		A	9
Drive power,						
channel 21	4		4		W	8
channel 45	2		2		W	8
channel 68	1		1		W	8
Bandwidth at −1 dB points	≥ 300		≥ 300		kHz	
Operating efficiency	28		37		%	

TYPICAL OPERATING CONDITIONS (ABC electrode YK1233, YK1235 at cathode potential)

As 25 kW vision transmitter (YK1230, YK1233, YK1234, YK1235)

								notes
Standard:	G	I	G	I	G	I		10
Channel	21		45		68			
Output power, peak sync.	27		27		27		kW	
Beam voltage	21	19	21.5	21.5	23.5	23.5	kV	
Beam current	3	3.45	2.8	2.8	2.5	2.55	A	6
Accelerator to cathode voltage	≈ 16	≈ 17.5	≈ 15	≈ 15	≈ 14	≈ 14	kV	7
Body current								
without drive	≈ 10	≈ 10	≈ 7	≈ 7	≈ 7	≈ 7	mA	
at black level	≈ 60	≈ 80	≈ 50	≈ 50	≈ 45	≈ 50	mA	
Focusing coil current	≈ 10	≈ 10	≈ 9	≈ 9	≈ 9	≈ 9	A	
Drive power, peak sync. max.	15	25	10	20	10	20	W	8
Operating efficiency	42	41	45	45	46	45	%	
Minimum efficiency	41	40	44	44	44	43	%	

Sound transmitter

Output power	2.7		5.5		kW	
Beam voltage	19	23.5	19	23.5	kV	
Beam current	0.47	0.38	0.7	0.55	A	6
Accelerator to cathode voltage	≈ 4.7	≈ 4.1	≈ 5.5	≈ 4.5	kV	7
Body current	≈ 15		≈ 15		mA	
Focusing coil current	≈ 8		≈ 10		A	9
Drive power,						
channel 21	4		4		W	8
channel 45	2		2		W	8
channel 68	1		1		W	8
Bandwidth at −1 dB points	≥ 300		≥ 300		kHz	
Operating efficiency	30		41		%	

TYPICAL OPERATING CONDITIONS (ABC electrode YK1235 at cathode potential)

As 30 kW vision transmitter (YK1234, YK1235)

Standard:	G	M	K	G	M	K	G	M	K		notes
Channel	21	14	21	42	42	42	62	69	62		
Output power, peak sync.	33	33	33	33			33			kW	
Beam voltage	23	23	21.4	24.3			25.3			kV	
Beam current	3.4	3.4	3.75	3.0			2.9			A	6
Accelerator to cathode voltage	≈ 17.7	≈ 17.7	≈ 18.8	≈ 16.2			≈ 15.9			kV	7
Body current											
without drive	≈ 10	≈ 10	≈ 10	≈ 7			≈ 7			mA	
at black level	≈ 50	≈ 50	≈ 50	≈ 45			≈ 40			mA	
Focusing coil current	≈ 9	≈ 9	≈ 10	≈ 8.5			≈ 8.5			A	
Drive power, peak sync. max.	25	25	25	20			20			W	8
Operating efficiency	42	42	41	45			45			%	
Minimum efficiency	41	41	40	44			44			%	

Sound transmitter

Output power		3.3		kW	
Beam voltage	23		25.3	kV	
Beam current	0.42		0.39	A	6
Accelerator to cathode voltage	≈ 4.5		≈ 4.2	kV	7
Body current		≈ 15		mA	
Focusing coil current		≈ 8.5		A	9

Drive power,

Standard	M	G, K			
channel	14	21	4	W	8
channel	42	42	2	W	8
channel	69	62	1	W	8

Bandwidth at −1 dB points	≥ 300	kHz	
Operating efficiency	34	%	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 4.3 to 4.5 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ · cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For cathode current versus accelerator-to-cathode voltage, see Fig. 5.
7. The accelerator electrode has to be connected to its supply (power supply or voltage divider) via a 10 kΩ resistor.
   For adjusting the cathode current a voltage divider should be dimensioned according to an accelerator electrode current of max. 1.5 mA.
8. The drive power is defined as the power delivered to a matched load.
9. Value is not critical. It may be set in accordance to the vision klystron focusing coil current. Operation of one vision and one sound klystron focusing unit in series is admitted.
10. Standard I: klystron tuned to frequency response according Fig. 3.

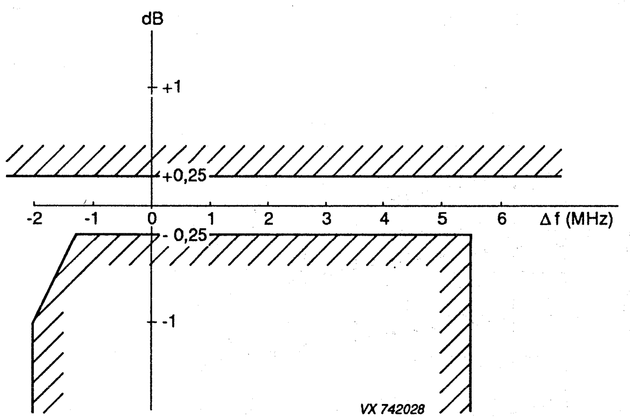


Fig. 3.

11. Optional.
12. The output coupler TE1187C comprises a standard loop (Type No 1). For certain channels special (optional) coupling loops are required.

TE1187R (Type No 2)	for vision/sound operation at channel 32/31 (8 MHz raster) resp. 28, 29/28 (6 MHz raster)
TE1187S (Type No 3)	for operation above channel 62 (8 MHz raster) resp. 68 (6 MHz raster)

13. In any case cavity 4 must be equipped with an arc detector. It is recommended to equip also the penultimate cavity (position 3) with an arc detector when the klystron is operated with an output power ≥ 15 kW (vision), ≥ 8 kW (sound).

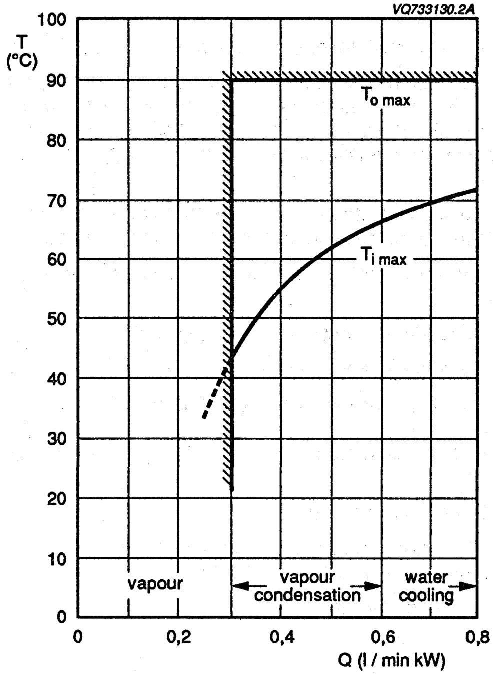


Fig. 4.

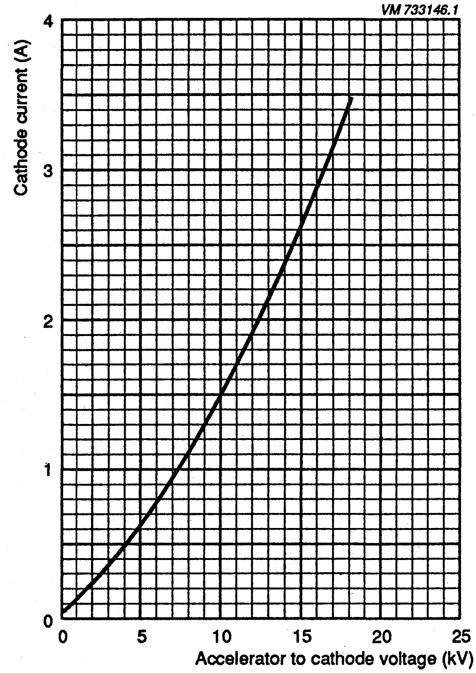


Fig. 5.

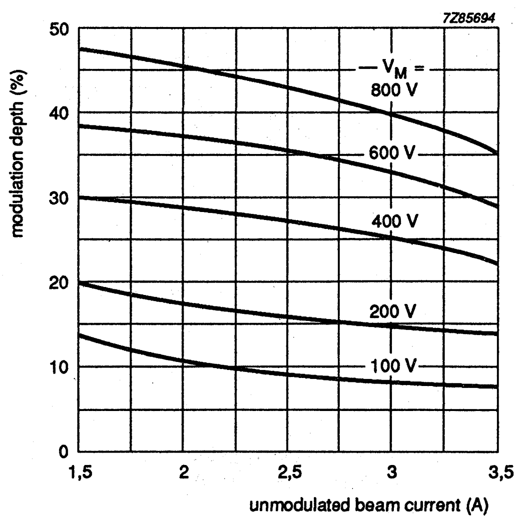


Fig. 6. ABC-operation for YK1233 and YK1235
Parameter: modulation voltage $-V_M$
(with respect to cathode).

HIGH-POWER KLYSTRONS

Fixed frequency, high-power klystron in metal-ceramic construction, for use in scientific and industrial applications. The tube has internal cavities, solenoid focusing, and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	1300	MHz
Bandwidth		note 1
Pulse output power	330	kW
Cooling		
collector	water	
body	air	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c.

Cathode: dispenser type

		min.	typ.	max.		
Heater voltage	V_f	7	7.8	8.5	V	note 2
Heater current	I_f	31	32	33	A	
Cold heater resistance	R_{fo}	–	30	–	mΩ	
Waiting time	t_w	10	15	–	minutes	

FOCUSING: electromagnetic

	min.	typ.	max.	
Solenoid current	11	12	13	A
Solenoid voltage	–	–	200	V

ION-GETTER PUMP SUPPLY

	min.	typ.	max.	
Operating voltage	3	4	5	kV
Operating current	–	$5 \cdot 10^{-3}$	5	mA
Internal resistance of power supply	–	300	–	kΩ

Notes

1. Bandwidth, see Fig. 1.
   An input signal with an edge of 1 μs will be transmitted without discernable overshooting of the output signal.
2. Typical values are adjusted at the supplied heater transformer, which is mounted inside of the oil container (primary voltage 220 V).

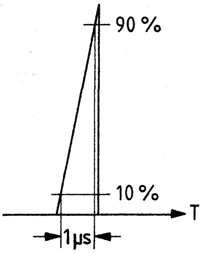


Fig. 1.

MECHANICAL DATA

Dimensions in mm

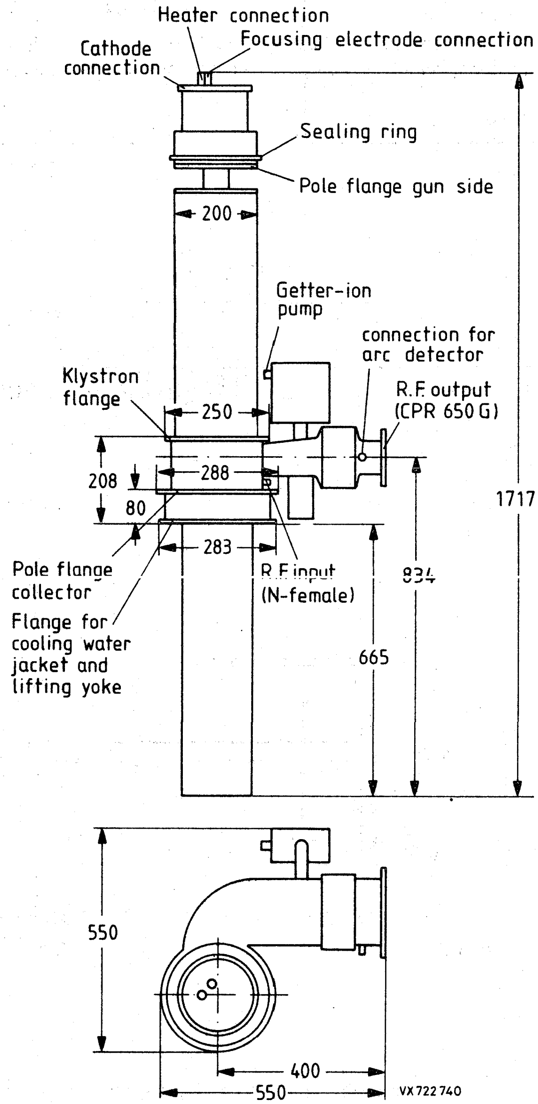


Fig. 2.

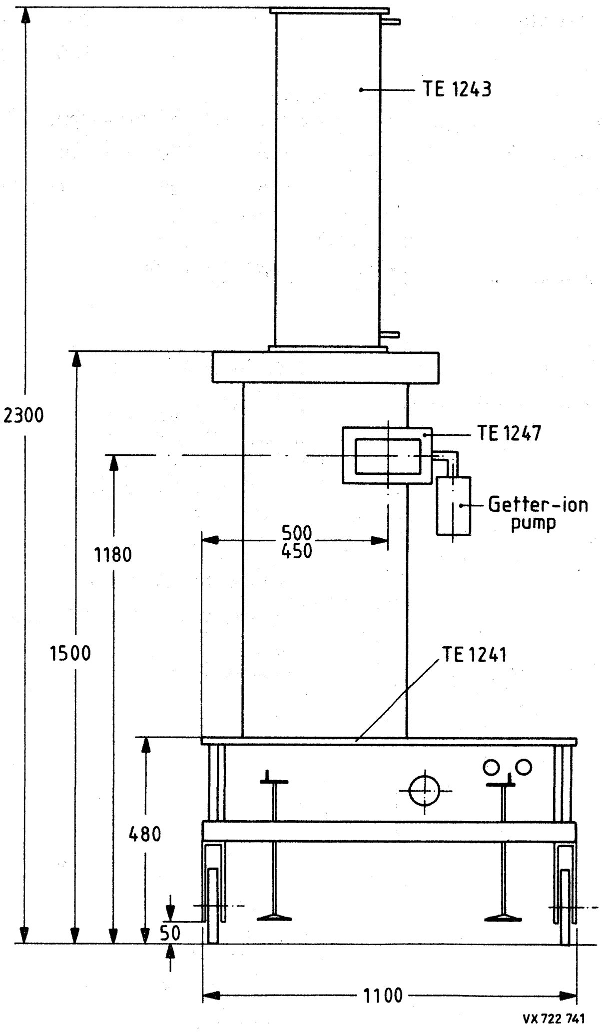


Fig. 3 Complete assembly consisting of tube, trolley, oil tank, focus mount, r.f. transition and operational lead shieldings.

COOLING

Cooling is achieved by demineralized water with 10 % stabilized glycol added

	min.	typ.	max.		
pressure in any cooling water circuit	–	–	900	kPa	(= 9 bar)
pressure drop	–	–	100	kPa	(= 1 bar)
Collector					
cooling water flow rate	8	15	30	ℓ/min	
inlet water temperature	+15	+20	+30	°C	
outlet water temperature	+15	+25	+60	°C	

MASS

Net mass of complete assembly — 350 kg

DIMENSIONS

Tube and mounting frame	see drawings
Required ground clearance for lifting hoist	min. 450 cm
Capability of hoist	min. 250 kg

MOUNTING — vertical, collector up

R.F. CONNECTORS

Input	N-type, female, 50 Ω
Output	waveguide WR650 / CRP650G

OIL CONTAINER, contents — approx. 70 ℓ

ACCESSORIES

A. Tube parts (factory fitted)

The tube will be shipped without additional factory fitted parts.

B. Operational parts for first equipment

Operational frame, consisting of trolley, oil container, heater transformer, di/dt sensor, focusing coil unit and cathode plug-connections	TE1241
Collector water cooling jacket	TE1243
Temperature sensors for water inlet, —outlet and collector	TE1245
30^{o} waveguide bend (H-plain)	TE1247

C. Optional parts

H.V. cable with R3 plugs, length 6 m	TE1159
H.V. dummy plug R3	TE1161

D. Parts for handling

Yoke for lifting klystron vertically	TE1251
Lifting frame for storage and any movement of a burnt-out or spare klystron in any other position than vertical	TE1253

LIMITING VALUES (Absolute maximum rating system)

Heater voltage, a.c.	max.	8.5	V	
Heater current, a.c.	max.	33	A	note 1
Cathode voltage to body	max.	−65	kV	
Cathode current	max.	12	A	
Collector dissipation	max.	650	kW	note 2
Pulse output power	max.	330	kW	
Pulse length	max.	2	s	
Ratio	max.	1/100		
Load VSWR	max.	1.2		
Input power, d.c.	max.	650	kW	

TYPICAL OPERATING CONDITIONS

325 kW pulse output power (VSWR < 1.1)	typ.	
Cathode voltage	−60	kV
Cathode current	11	A
Input power, d.c.	600	kW
Collector dissipation	330	kW
Efficiency	50	%
Drive power	27	W
Pulse length	1.5	s
Ratio	1/200	

PERFORMANCE DATA

Phase shift to cathode current	< 20	°/A
Phase shift to rel. cathode voltage	< 20	°/%
R.F. output to rel. cathode voltage	< 0.3	dB/%
Harmonic levels to fundamental	< 30	dB
Signal-to-noise ratio	> 50	dB

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 40 A.
2. Maximum dissipation can be tolerated up to 0.5 s.

INSTALLATION AND OPERATION REQUIREMENTS

A. Required interlocks

1. Fast switch-off of the drive power within 10 ms has to be done if the arc detector and/or r.f. reflection indicator is activated. An arc detector must be provided at the output waveguide.
2. A fast switch-off of the beam supply has to be provided when one of the following situations occurs:
   a) the beam current increases rapidly,
   b) the solenoid current deviates by more than ±5% from the adjusted value,
   c) when the body current exceeds 500 mA.

   The switching sensors and the discharge facilities for the power supply must be designed so that a copper wire of 0.35 mm diameter, connected to the power supply instead of the klystron (length approx. 1 cm/kV), will not be destroyed, if the full operating voltage is switched on and applied to the wire.
3. The mains for the beam power supply has to be switched off within 100 ms when one of the following situations occur:
   a) the collector temperature monitor (with internal thermocouple) is activated (adjusted to maximum temperature),
   b) the monitored temperature differences between inlet and outlet in the collector and/or body cooling circuits are too high;

   max. values permitted: $\Delta\theta = 30$ K

   c) the beam current either exceeds the limiting value or increases by more than 30% or max. 2 A above the adjusted value,
   d) the water flow of the collector and body cooling circuit decreases below the required minimum value.

Restarting is not allowed within 10 s after any interruption.

B. Switching-on and off sequence

Switching-on sequence

1. Getter-ion pump supply on.
2. Check that the pump current is < 1 mA.
3. Heater voltage supply on.
4. Wait for preheating time (min. 10 minutes).
5. Cooling of focusing.
6. Collector cooling supply on.
7. Solenoid current supply on.
8. R.F. drive on.
9. Beam voltage supply on.

Switching-off sequence

1. Beam voltage supply off.
2. All other supplies and cooling circuits off.

C. Radiation dangers

RF radiation

RF power may be emitted not only through the normal output coupling but also through other apertures (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.

X-radiation

Due to the high accelerating voltage, the klystron generates a high level of X-rays. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
The tube manufacturer recommends a shielding made from lead sheets at least 3 mm thick and capable of reducing the X-radiation to a safe level.
The compliance with the local regulations regarding radiation hazards has to be confirmed by the user. If in any doubt refer to your local PHILIPS representative or the manufacturer.
Care must be taken in the construction of this shielding to avoid any holes or slots.

CONTINUOUS-WAVE HIGH-POWER KLYSTRON

Water cooled, high efficiency, fixed frequency, continuous-wave high-power klystron in metal-ceramic construction, for use in scientific and industrial applications. The tube has internal cavities, solenoid focusing, beam control by accelerator anode and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	999.3	MHz
Bandwidth at saturation (−1 dB points)	4	MHz
Output power	400	kW
Cooling	water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c. or d.c.

Cathode: dispenser type

		min.	typ.	max.		
Heater voltage	V_f	8.0	8.5	9.0	V	
Heater current	I_f	24	26	28	A	notes 1, 2
Cold heater resistance	R_{fo}	–	30	–	mΩ	
Waiting time	t_w	10	–	–	minutes	

FOCUSING: electromagnetic

	min.	typ.	max.	
Solenoid current	–	–	20	A
Solenoid voltage	–	–	200	V
Solenoid resistance	–	10	–	Ω

ION-GETTER PUMP SUPPLY

	min.	typ.	max.	
Operating voltage	3	3.3	4	kV
Operating current	–	10^{-3}	80	mA
Internal resistance of power supply	25	300	–	kΩ

MECHANICAL DATA

Dimensions in mm

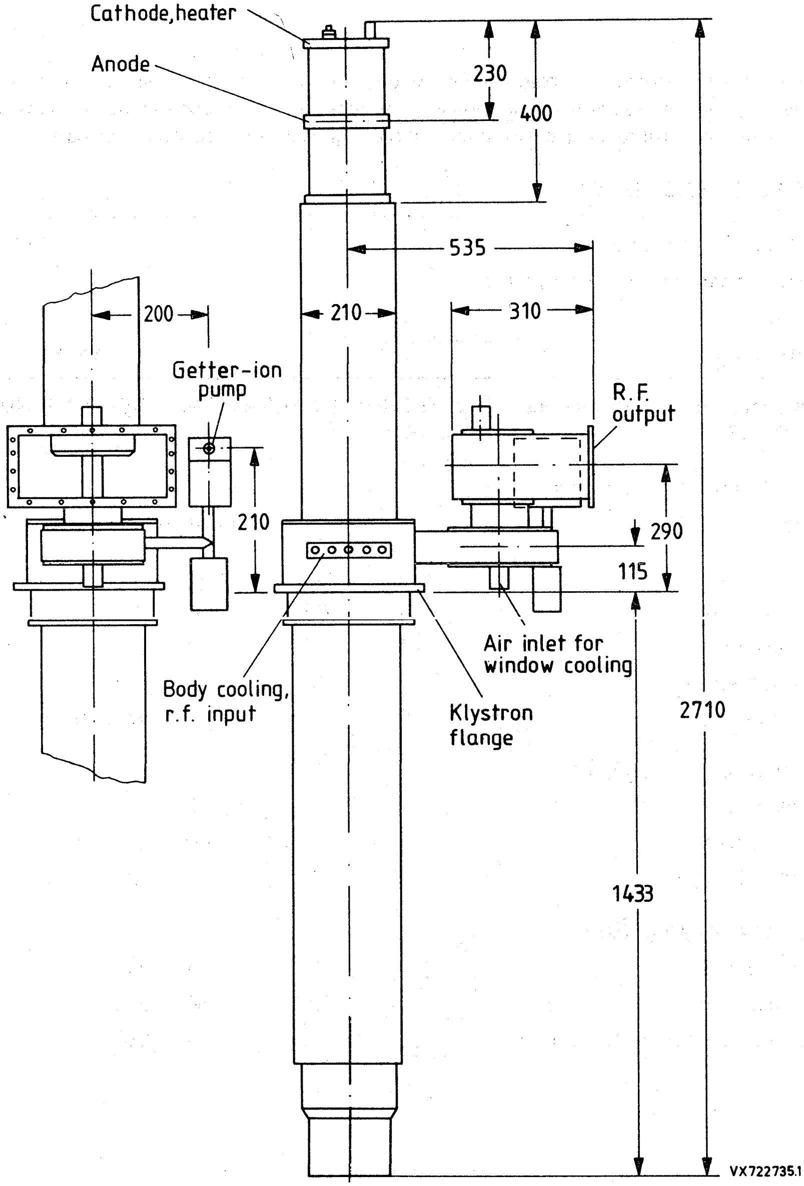


Fig. 1.

Tube mounted in the mounting frame with solenoid.

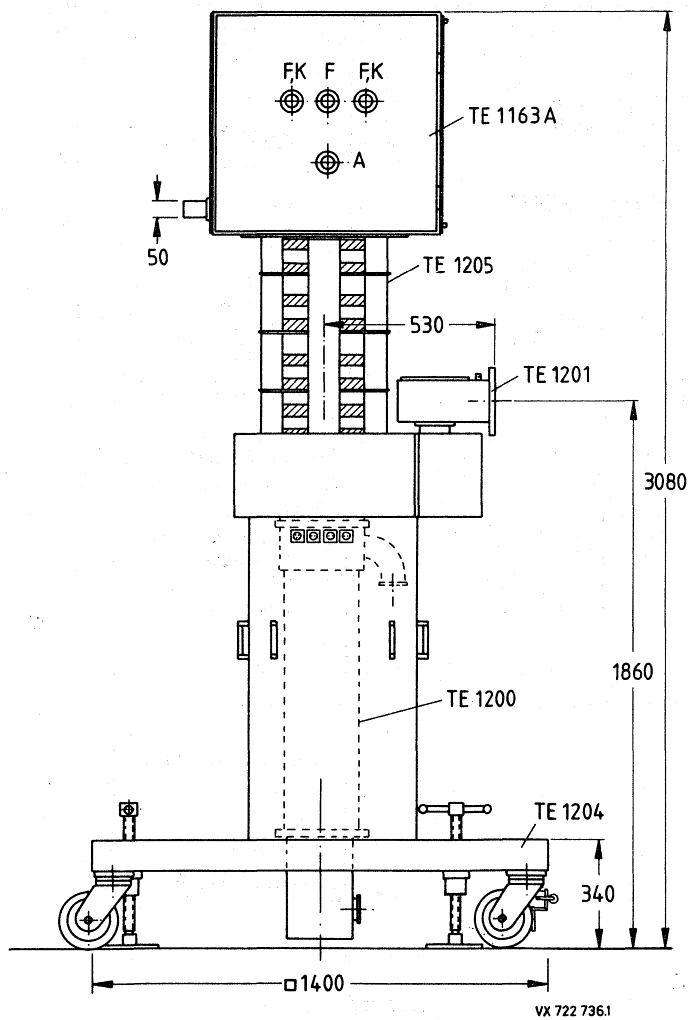


Fig. 2.

COOLING	min.	typ.	max.		
Collector					
demineralized or distilled water with 10% stabilized glycol added	350	450	550	ℓ/min	note 3
pressure drop	—	100	—	kPa	(= 1 bar)
Body circuit I					
demineralized or distilled water with 10% stabilized glycol added	5	7	—	ℓ/min	note 3
pressure drop	—	300	—	kPa	(= 3 bar)
Body circuit II					
demineralized or distilled water with 10% stabilized glycol added	7	9	—	ℓ/min	note 3
pressure drop	—	300	—	kPa	(= 3 bar)
Cathode socket and accelerator anode					
air	2	—	—	m^3/min	
pressure drop	—	—	500	Pa	(= 5 mbar)
Output window					
air	—	2	—	m^3/min	
pressure drop	—	2	—	kPa	(= 20 mbar)
Inlet water temperature	—	—	+50	^oC	
Inlet air temperature	—	—	+45	^oC	

MASS

Net mass YK1250		300 kg
Mounting frame with solenoid		750 kg
Capability of hoist	min.	600 kg

DIMENSIONS

Tube and mounting frame	see drawings
Required ground clearance for lifting hoist	min. 450 cm

MOUNTING vertical, cathode up

R.F. CONNECTORS

Input	N-type, female
Output	waveguide R9 (WR – 975)

ACCESSORIES

A. Tube parts

Waveguide coupling iris (if required)		note 4
Magnet for getter-ion pump (factory fitted)		

B. Operational parts for first equipment

Collector water cooling jacket	TE1200	
Waveguide transition, R9	TE1201	note 5
Anode ring	TE1202	
Cathode ring	TE1203	
H.V. connection unit with four R3 sockets	TE1163A	note 6
Klystron trolley	TE1204	
Focusing coil unit	TE1205	
Connection cables		
heater/cathode	2 x TE1206A	
heater	1 x TE1206B	
accelerator anode	1 x TE1206C	

C. Parts for handling

		note 7
Yoke for lifting TE1205 and TE1163	TE1208	
Yoke for lifting and turning a klystron from any position	TE1209	
Supporting frame for storage and any movement of burnt-out or spare klystrons in any position other than vertical	TE1210	
Trolley for transportation of a klystron in horizontal position without lifting gear	TE1211	

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 10% above specified values			
Cathode voltage to body (ground)	max.	−61	kV	
Cold cathode voltage to body (ground)	max.	−65	kV	
Cathode current	max.	12	A	
Accelerator anode voltage to cathode	max.	41	kV	note 8
Cold accelerator anode voltage to cathode	max.	45	kV	
Accelerator anode current	max.	10	mA	
Collector dissipation	max.	700	kW	note 9
Dissipation body circuit I	max.	10	kW	
Dissipation body circuit II	max.	10	kW	
C.W. output power	max.	420	kW	
Load VSWR	max.	1.2		note 10
Temperature rise, window cooling air flow	max.	70	K	

TYPICAL OPERATING CONDITIONS

350 kW operation into matched load	min.	typ.	max.		
Cathode voltage to body (ground)	−54	−56	−57	kV	
Cathode current	0	10.4	11	A	
Input power, d.c.	–	614	–	kW	
Accelerator anode voltage to cathode	–	31	–	kV	
Accelerator anode current	–	1	5	mA	
C.W. output power, VSWR ≤ 1.1	330	350	–	kW	
Collector dissipation	–	264	500	kW	note 9
Efficiency	55	57	–	%	
C.W. drive power	–	20	40	W	

400 kW operation into matched load					
Cathode voltage to body (ground)	–	−60.3	–	kV	
Cathode current	–	11.8	12	A	
Input power, d.c.	–	712	–	kW	
Accelerator anode voltage to cathode	–	34.5	40	kV	
Accelerator anode current	–	0.3	5	mA	
C.W. output power, VSWR ≤ 1.1	–	418	–	kW	
Collector dissipation	–	294	500	kW	note 9
Efficiency	56	58	–	%	
C.W. drive power	–	9	40	W	

PERFORMANCE DATA

Phase shift to cathode current	<	20	°/A
Phase shift to rel. cathode voltage	<	20	°/%
Phase shift to r.f. drive	<	12	°/dB
R.F. output to rel. cathode voltage	<	0.3	dB/%
Spurious noise amplitude			
for f < 300 Hz	⩽	3	%
for f = 300 to 1000 Hz	⩽	1	%
for f > 1000 Hz	⩽	0.5	%

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 60 A.
2. Required values are given with each tube.
3. For further recommendations please contact the tube manufacturer.
4. Separately shipped together with each tube and to be returned together with each burnt-out tube.
5. It is recommended to return the coaxial waveguide transition together with burnt-out tube for inspection.
6. R3 sockets are only usable together with optional R3 plugs.
7. These parts are needed for all handling operations at the site (only one set required).
8. The accelerator anode voltage may never become positive with respect to the body (ground).
9. It must be observed that for operation with reduced r.f. drive the maximum value for collector dissipation is not exceeded.
10. For reflections exceeding this value please contact the tube manufacturer.

INSTALLATION AND OPERATION REQUIREMENTS

A. Required interlocks

1. Fast switch-off of the drive power within 10 ms has to be done if the arc detector and/or r.f. reflection indicator is activated. An arc detector must be provided at the knee of the output wave-guide.
2. A fast switch-off of the beam supply has to be provided when one of the following situations occurs:
   a) the beam current increases rapidly,
   b) the solenoid current deviates by more than ±5% from the adjusted value.

   The switching sensors and the discharge facilities for the power supply must be designed so that a copper wire of 0.35 mm diameter, connected to the power supply instead of the klystron (length approx. 1 cm/kV), will not be destroyed, if the full operating voltage is switched on and applied to the wire.
3. The mains for the beam power supply has to be switched off within 100 ms when one of the following situations occur:
   a) the beam current either exceeds the limiting value or increases by more than 30% or max. 2 A above the adjusted value,
   b) the pump current exceeds 10 μA ,
   c) the collector temperature monitor (with internal thermocouple) is activated (switch-off value adjustable between 30 and 60 K above the water inlet temperature),
   d) the monitored temperarure differences between inlet and outlet in the collector and/or body cooling circuits are too high;

max. values permitted:	collector	$\Delta\theta$ = 15 K
	body circuit I	$\Delta\theta$ = 15 K
	body circuit II	$\Delta\theta$ = 15 K

   e) the water flow of the collector and body cooling circuits decreases below the required minimum value,
   f) the air flow for the r.f. window and cathode cooling decreases below the required minimum value.
4. Switch-off the heater voltage for pump current > 4 mA.

Restarting is not allowed within 10 s after any interruption.

B. Switching-on and off sequence

Switching-on sequence

1. Cathode cooling on.
2. Getter-ion pump supply on.
3. Check that the pump current is < 10 μA.
4. Heater voltage supply on.
5. Wait for preheating time (min. 15 minutes).
6. Cooling air r.f. window on.
7. Cooling body circuits I and II on.
8. Collector cooling supply on.
9. Solenoid current supply on.
10. Check that the heater current has reached the adjusted value ± 0.5 A.
11. R.F. drive on.
12. Beam voltage supply on.

Switching-off sequence

1. Beam voltage supply off.
2. All other supplies and cooling circuits off.

C. Radiation dangers

RF radiation

RF power may be emitted not only through the normal output coupling but also through other apertures (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.

X-radiation

Due to the high accelerating voltage, the klystron generates a high level of X-rays. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
The tube manufacturer recommends a shielding made from lead sheets at least 3 mm thick and capable of reducing the X-radiation to a safe level.
The compliance with the local regulations regarding radiation hazards has to be confirmed by the user. If in any doubt refer to your local PHILIPS representative or the manufacturer.
Care must be taken in the construction of this shielding to avoid any holes or slots.

UHF POWER KLYSTRONS

For UHF band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
Comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860	MHz
Output power as vision transmitter		
YK1263	40	kW
YK1265	55 and 60	kW
Cooling	vapour, vapour condensation, or water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by DC					notes
Cathode	dispenser type				
Heater voltage	V_f		7.8	V *	
Heater current	I_f	≈	22.5 to 26.5	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	

FOCUSING

Focusing coil current			
vision operation		10 to 12	A
sound operation		9 to 12	A
Resistance of focusing coils			
cold (20 °C)		7.2 to 9.5	Ω
operating at an ambient temperature of 20 °C	≤	11	Ω

BEAM CONTROL 6, 7

The klystrons comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 7.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

ION-GETTER PUMP SUPPLY 3

Pump voltage, no-load condition	3 to 4	kV
Internal resistance of supply	300	kΩ

* The tube must be operated with $V_f = 8.3$ V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or −2%.

MECHANICAL DATA

Dimensions in mm

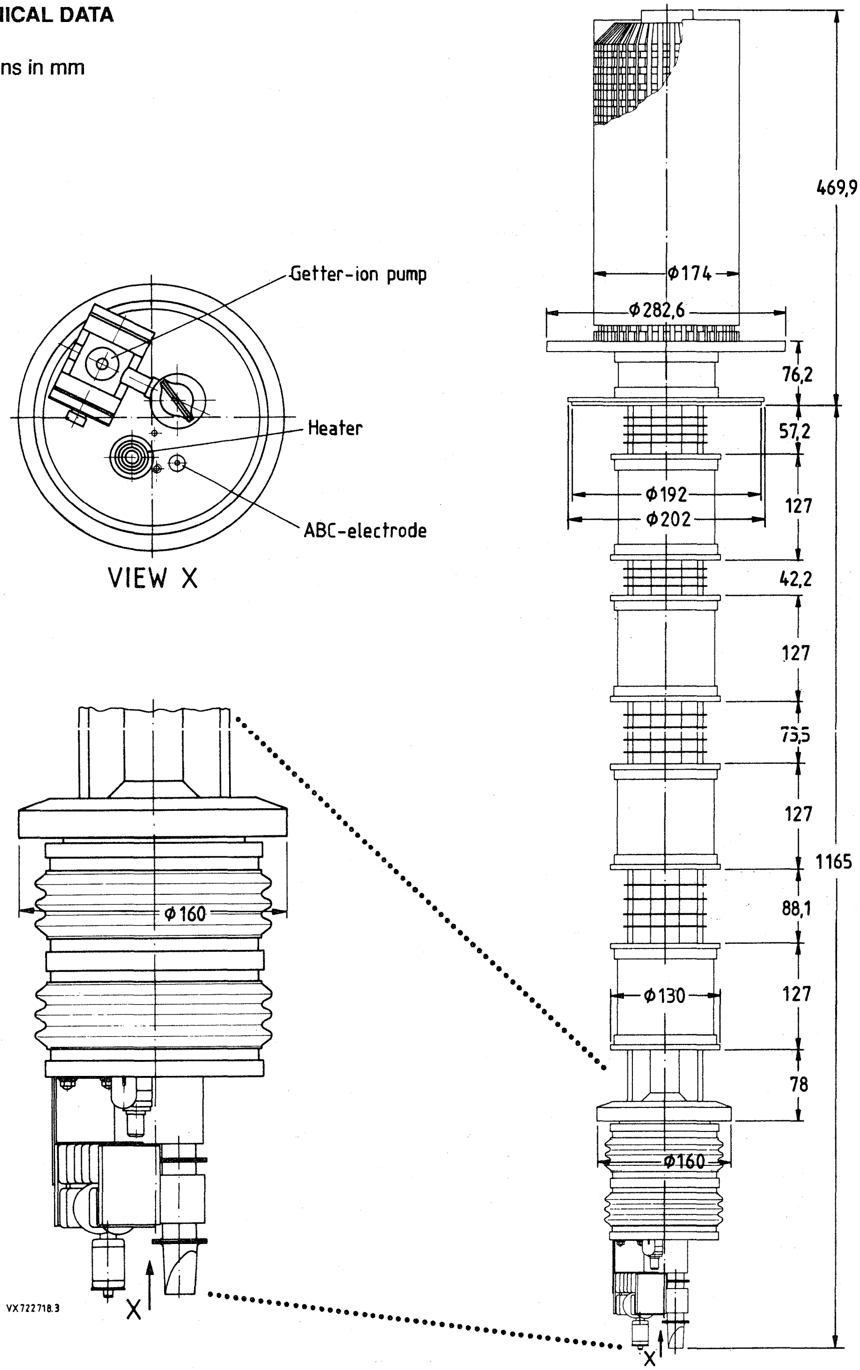


Fig. 1.

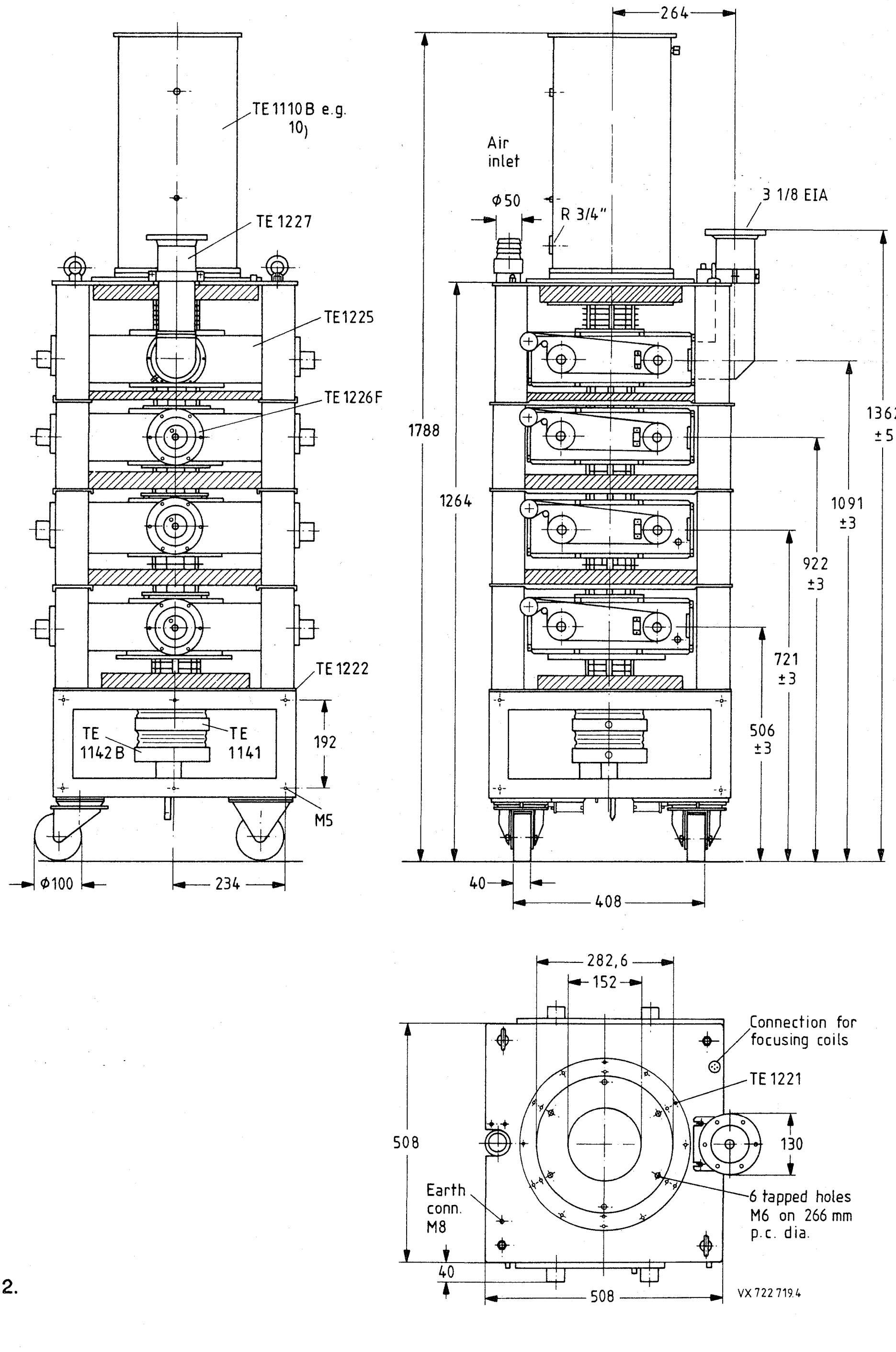

TE 1110 B e.g.
10)
TE 1227
TE 1225
TE 1226 F
TE 1222
TE
1142 B
TE
1141
192
M5
ϕ100
234
264
Air
inlet
ϕ50
R 3/4"
3 1/8 EIA
1788
1264
1362
±5
1091
±3
922
±3
721
±3
506
±3
40
408
282,6
152
Connection for
focusing coils
TE 1221
508
130
Earth
conn.
M8
6 tapped holes
M6 on 266 mm
p.c. dia.
40
508
VX 722 719.4

Fig. 2.

MASS AND DIMENSIONS

Klystron		
net	approx. 79	kg
gross	approx. 245	kg
outline dimensions of packing (cm)	182 x 75 x 75	
Cavities	approx. 70	kg
Magnet frame with coils	approx. 255	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3 m, excluding hoist, is required.

COOLING

			notes
YK1263	Cavities 1, 2, 3 and 4, drift tubes 4 and 5 and cathode socket via manifold	forced air, T_i max. 50 °C, $q \approx 2\ m^3/min$, Δp = 1600 Pa (16 mbar)	13
YK1265	Cavities 1, 2, 3 and 4, drift tube 4 and cathode socket via manifold	forced air, T_i max. 50 °C, $q \approx 3\ m^3/min$, Δp = 1600 Pa (16 mbar)	13
	Drift tube 5, separate cooling	forced air, T_i max. 50 °C, $q \approx 3\ m^3/min$, flow area $\approx 50\ cm^2$	13
Cathode socket only, during black heat		forced air, T_i max. 50 °C, $q \approx 0.15\ m^3/min$	
Collector		vapour with boiler TE1110B, volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 l/min steam per kW collector dissipation water or vapour condensation (with water jacket TE1194B) q = 35 to 60 l/min, T_o max 90 °C, see Fig. 3. For 60 l/min, Δp = 100 kPa (1 bar)	4, 12

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1222	
Collector radiation suppressor	TE1221	
Collector jacket for water or vapour condensation cooling	TE1194B	note 10
Boiler for vapour cooling	TE1110B	note 10
Temperature sensor	TE1199	
Anode ring	TE1141	
Cathode ring	TE1142B	
Spark gap	TE1183	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1146	
Cavities, continuously tunable	4 x TE1225	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	2 x TE1107C	note 11
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1226F	
Output coupler, 3 1/8 inch, 90° elbow	TE1227	
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	28	kV	
Cold cathode voltage	max.	–30	kV	
Beam current	max.	7	A	note 6
Body current RF on	max.	150	mA	
Accelerator electrode current	max.	6	mA	note 5
Collector dissipation	max.	160	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1194B	max.	600	kPa (6 bar)	
ABC-electrode voltage with respect to cathode	max.	–1.4	kV	

PERFORMANCE DATA

of ABC-electrode	min.	typ.	max.	
Capacity	80	90	100	pF
DC current at –1000 V *	-	-	1	mA

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1222 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

* The DC electrode current may rise up to max. 2 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 2 mA.

TYPICAL OPERATING CONDITIONS (ABC electrode at cathode potential)

As 40 kW vision transmitter (YK1263)

						notes
Standard G						
Channel	21	45	62	68 *		
Output power, peak sync.	45	45	45	45	kW	
Beam voltage	21	22.5	24.5	26.5	kV	
Beam current	5.2	4.45	4.15	4.1	A	6, 7
Accelerator to cathode voltage	19	17.5	16.5	16.4	kV	5
Body current						
without drive	8	5	5	5	mA	
at black level	60	30	30	30	mA	
Focusing coil current	11	10.5	10	10	A	
Drive power, peak sync. max.	20	10	10	10	W	8
Operating efficiency	41	45	44	42	%	
Bandwidth at –1 dB points	7	7	7	7	MHz	9

As 55 kW vision transmitter (YK1265)

Standard	M/G	M/G	M/G	M/G		
Channel	14/21	45/44	69/62	77/68 *		
Output power, peak sync.	58	58	58	58	kW	
Beam voltage	23	25	26	26,5	kV	
Beam current	6.0	5.05	4.85	4.85	A	6, 7
Accelerator to cathode voltage	21.5	19	18.5	18,5	kV	5
Body current						
without drive	8	5	5	5	mA	
at 58 kW peak sync., black level	80	40	40	40	mA	
Focusing coil current	11.5	11	10.5	10,5	A	
Drive power, peak sync.	20	10	10	10	W	
Operating efficiency	42	46	46	45	%	
Bandwidth at –1 dB points	7	7	7	7	MHz	9

* Tentative

						notes
As 60 kW vision transmitter (YK1265)						
Standard	M/G	M/G	M/G	M/G		
Channel	14/21	42/42	69/62	77/68 *		
Output power, peak sync.	64	64	64	64	kW	
Beam voltage	24.5	25.5	26.5	27	kV	
Beam current	6.1	5.3	5.15	5.25	A	6, 7
Accelerator to cathode voltage	21.5	20	18.5	19.3	kV	5
Body current						
without drive	8	7	5	5	mA	
at 64 kW peak sync., black level	80	60	40	40	mA	
Focusing coil current	11.5	11	10.5	10.5	A	
Drive power, peak sync.	20	10	10	10	W	8
Operating efficiency	43	47.5	47	45	%	
Bandwidth at –1 dB points	7	7	7	7	MHz	9
As 8 kW FM sound transmitter						
Output power	9	9	9	9	kW	
Beam voltage	21	22.5	24.5	26	kV	
Beam current	1.15	1.0	0.95	0.9	A	
Accelerator to cathode voltage	7	6.5	6	6	kV	5
Focusing coil current	9	9	9	9	A	
Drive power	5	5	5	5	W	8
Bandwidth at –1 dB points	1	1	1	1	MHz	
As 11 kW FM sound transmitter						
Output power	12	12	12	12	kW	
Beam voltage	23	25	26	26.5	kV	
Beam current	1.4	1.2	1.1	1.1	A	
Accelerator to cathode voltage	8	7.5	7	7	kV	7
Focusing coil current	9	9	9	9	A	
Drive power	5	5	5	5	W	8
Bandwidth at –1 dB points	1	1	1	1	MHz	
As 12 kW FM sound transmitter						
Output power	13	13	13	13	kW	
Beam voltage	24.5	25.5	26.5	27	kV	
Beam current	1.4	1.3	1.2	1.2	A	
Accelerator to cathode voltage	8	7.5	7.5	7.5	kV	7
Focusing coil current	9	9	9	9	A	
Drive power	5	5	5	5	W	8
Bandwidth at –1 dB points	1	1	1	1	MHz	

* Tentative

As 60 kW vision transmitter (YK1265)

						notes
Standard	M/G	M/G	M/G	M/G		
Channel	14/21	42/42	69/62	77/68 *		
Output power, peak sync.	64	64	64	64	kW	
Saturated output power	68	68	68	68	kW	
Beam voltage	25	26	27	27.5	kV	
Beam current	6.3	5.5	5.35	5.5	A	6, 7
Accelerator to cathode voltage	22	20	19.6	19.5	kV	5
Body current						
without drive	8	7	5	5	mA	
at 64 kW peak sync., black level	80	60	40	40	mA	
Focusing coil current	11	10.5	10	10	A	
Drive power, peak sync.	20	10	10	10	W	8
Saturated efficiency	43	47.5	47	45	%	
Bandwidth at –1 dB points	7	7	7	7	MHz	9

As 6 kW FM sound transmitter

Output power	6.4	6.4	6.4	6.4	kW	
Beam voltage	25	26	27	27.5	kV	
Beam current	0.85	0.77	0.72	0.7	A	
Accelerator to cathode voltage	5.3	5.0	4.8	4.8	kV	5
Focusing coil current	10	9.5	9	9	A	
Drive power	5	5	5	5	W	8

CW operation for synchrotron radiation sources (YK1265)

Frequency	≈ 500	≈ 500	≈ 500	MHz
Output power	63	52	42	kW
Saturated output power	65	-	-	kW
Beam voltage	25.5	23	21	kV
Beam current	5.7	5.6	4.9	A
Body current	≈ 35	-	-	mA
Focusing coil current	≈ 10.5	-	-	A
Bandwidth at –3 dB points	3	-	-	MHz **

* Tentative

** The coarse tuning of the cavities is as follows:

Cavity 1	≈ –1	MHz
Cavity 2	≈ +1	MHz
Cavity 3	6 to 7	MHz
Cavity 4	on carrier	

The procedure is similar to the coarse tuning for sound operation according to manual.

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ · cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For beam current (tolerance ± 5 %) versus accelerator-to-cathode voltage, see Fig. 4.
7. A voltage divider for adjusting the beam current should be dimensioned on the basis of an accelerator electrode current of typical 1.5 mA. The accelerator electrode should be connected to its supply via a 10 kΩ resistor, designed to withstand the full beam voltage.
8. The drive power is defined as the power delivered to a matched load.
9. Variation of the signal level between black and white at any sideband frequency may cause a reaction of the peak sync. level. Proper tube design limits this reaction to less than 0.5 dB.
10. TE1110B with 1" inlet and steam outlet on top. TE1194B with two 1" tube fittings SWAGELOK SS–1610–1–16 at one side of the cooling jacket.
11. In any case cavity 4 must be equipped with an arc detector. It is recommended to equip also the penultimate cavity (position 3) with an arc detector when the klystron is operated with an output power ≥ 45 kW (vision), ≥ 25 kW (sound).
12. For operation at high altitudes where water boils at lower temperature the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
13. This value applies to transmitters at sea level. At high altitudes the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.

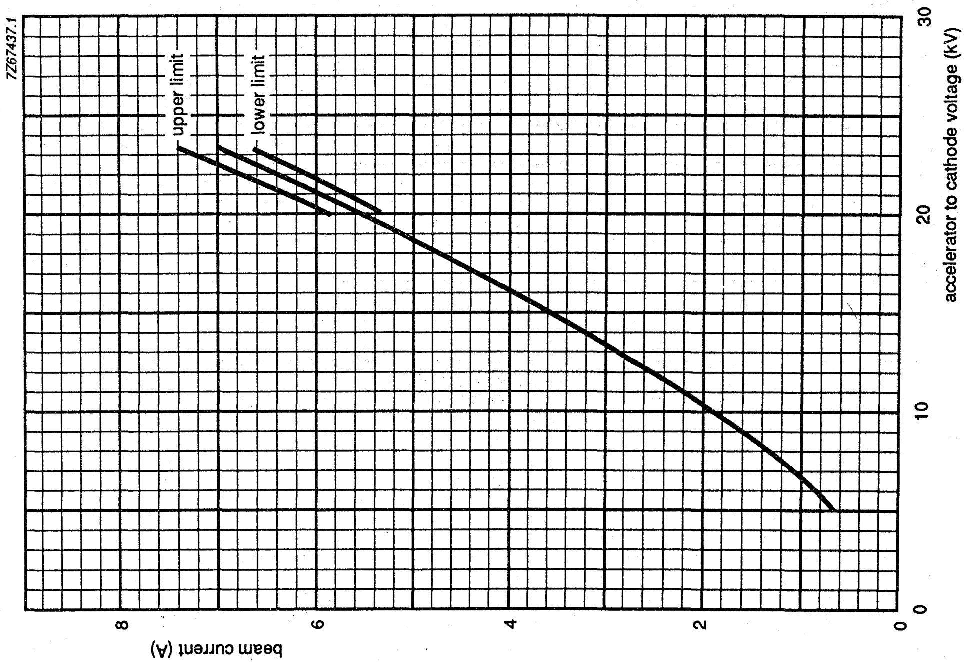


Fig. 4.

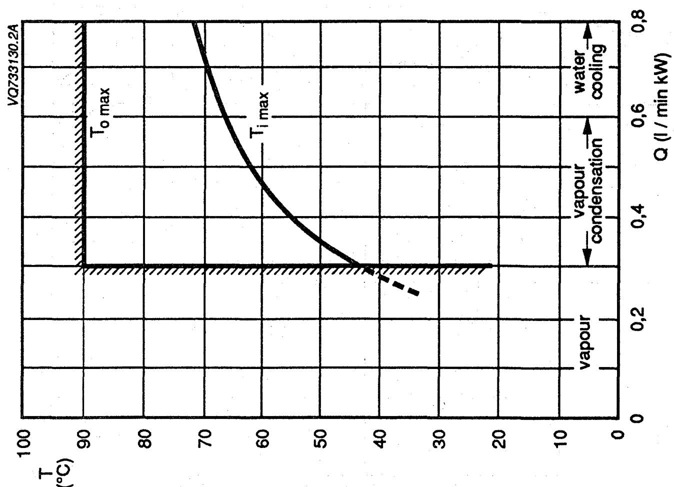


Fig. 3. *

* see note 12

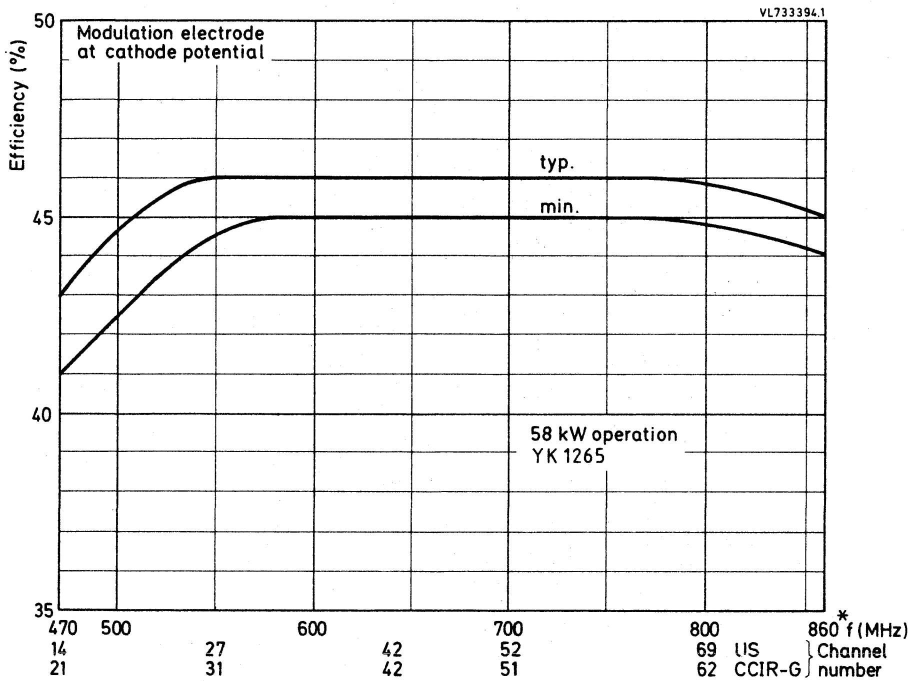


Fig. 5.

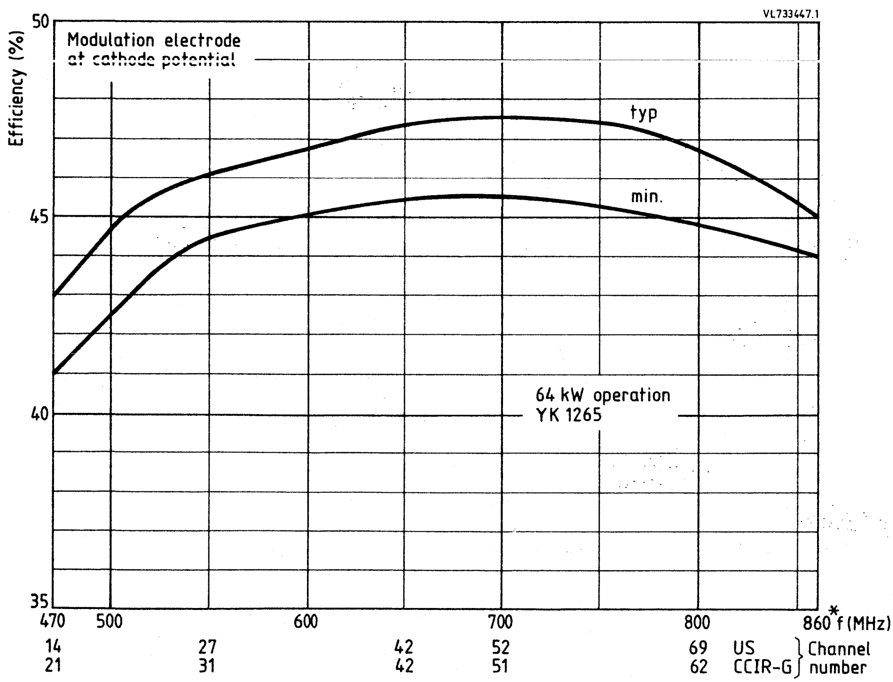


Fig. 6.

* Tentative

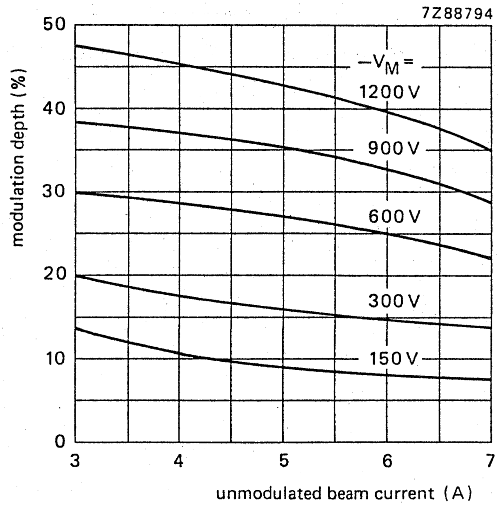


Fig. 7. ABC-operation.
Parameter: modulation voltage $-V_M$
(with respect to cathode).

UHF POWER KLYSTRON

For UHF band IV/V vision transmitters and sound transmitters.
Full frequency coverage 470 to 860 MHz in a single tube. Rated for 70 kW vision amplifier service and 60 kW CW operation.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
Air cooling of body and cavities.
Comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860	MHz
Output power as vision transmitter	70 and 60	kW
Cooling	vapour, vapour condensation, or water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by DC					notes
Cathode	dispenser type				
Heater voltage	V_f		7.8	V *	
Heater current	I_f	≈	22.5 to 26.5	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	

FOCUSING

Focusing coil current			
vision operation		10 to 12	A
sound operation		9 to 12	A
Resistance of focusing coils			
cold (20 °C)		7.2 to 9.5	Ω
operating at an ambient temperature of 20 °C	≤	11	Ω

BEAM CONTROL 6, 7

The klystrons comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 5.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

ION-GETTER PUMP SUPPLY 3

Pump voltage, no-load condition	3 to 4	kV
Internal resistance of supply	300	kΩ

* The tube must be operated with $V_f = 8.3$ V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or −2%.

MECHANICAL DATA

Dimensions in mm

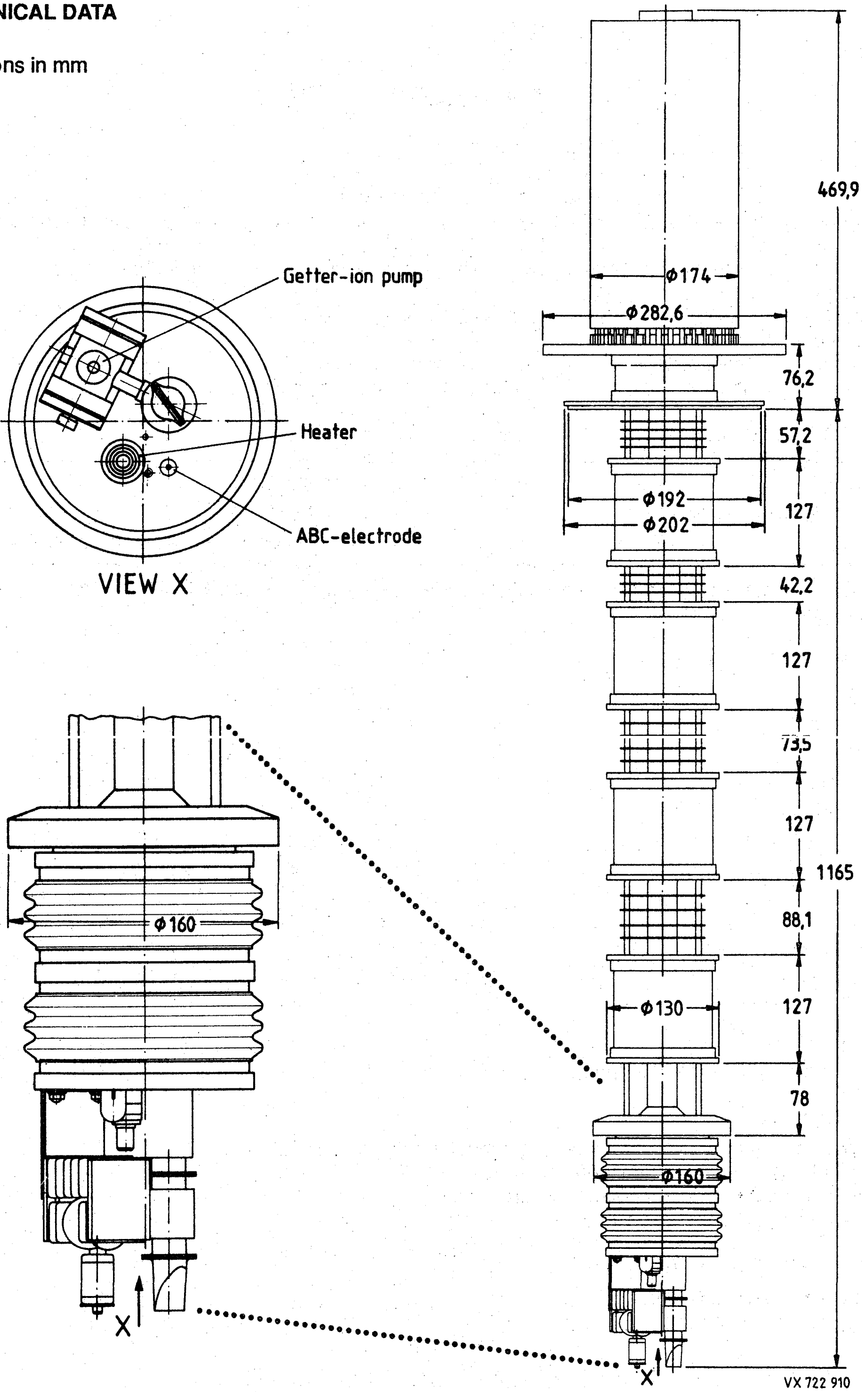


Fig. 1.

DEVELOPMENT DATA

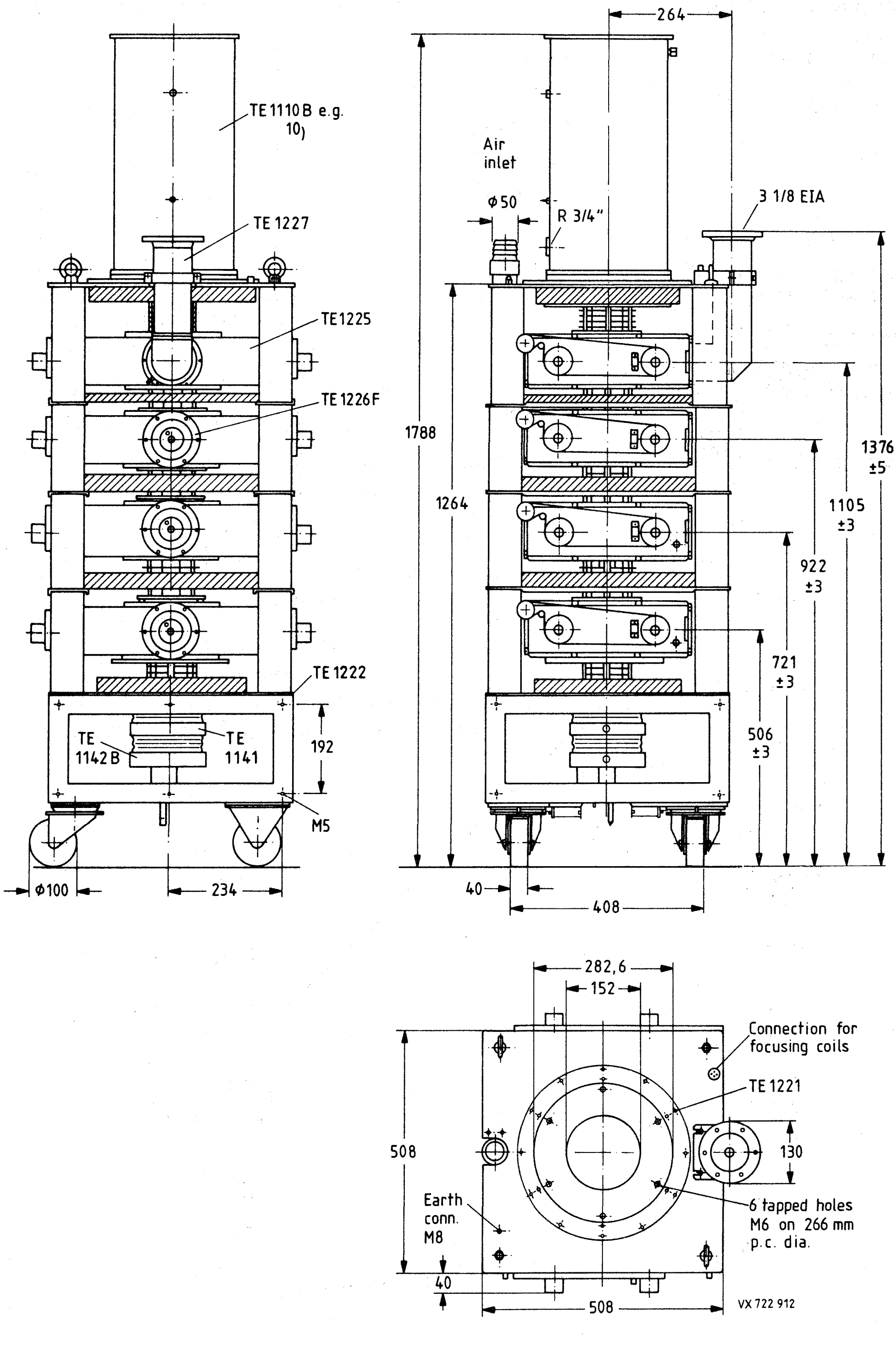


Fig. 2.

MASS AND DIMENSIONS

Klystron		
net	approx. 79	kg
gross	approx. 245	kg
outline dimensions of packing (cm)	182 x 75 x 75	
Cavities	approx. 70	kg
Magnet frame with coils	approx. 255	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3 m, excluding hoist, is required.

COOLING

		notes
Cavities 1, 2, 3 and 4, drift tube 4 and cathode socket via manifold	forced air, T_i max. 50 °C, $q \approx 4.8$ m^3/min, Δp = t.b.f. (< 2000 Pa, < 20 mbar)	13
Drift tube 5, separate cooling	forced air, T_i max. 50 °C, $q \approx 3$ m^3/min, flow area ≈ 50 cm^2	13
Cathode socket only, during black heat	forced air, T_i max. 50 °C, $q \approx 0.15$ m^3/min	
Collector	vapour with boiler TE1110B, volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 l/min steam per kW collector dissipation	4, 12
	water or vapour condensation (with water jacket TE1194B) q = 35 to 60 l/min, T_o max 90 °C, see Fig. 3. For 60 l/min, Δp = 100 kPa (1 bar)	

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1222	
Collector radiation suppressor	TE1221	
Collector jacket for water or vapour condensation cooling	TE1194B	note 10
Boiler for vapour cooling	TE1110B	note 10
Temperature sensor	TE1199	
Anode ring	TE1141	
Cathode ring	TE1142B	
Spark gap	TE1183	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1146	
Cavities, continuously tunable	4 x TE1225	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	2 x TE1107C	note 11
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1226F	
Output coupler, 3 1/8 inch, 90° elbow	TE1227	
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

DEVELOPMENT DATA

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	30	kV	
Cold cathode voltage	max.	–33	kV	
Beam current	max.	7	A	note 6
Body current with no input power	max.	35	mA	
Body current RF on	max.	150	mA	
Accelerator electrode current	max.	6	mA	note 5
Collector dissipation	max.	170	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1194B	max.	700	kPa (7 bar)	
ABC-electrode voltage with respect to cathode	max.	–1.4	kV	

PERFORMANCE DATA

of ABC-electrode	min.	typ.	max.	
Capacity	80	90	100	pF
DC current at –1000 V *	-	-	1	mA

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1222 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

* The DC electrode current may rise up to max. 2 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 2 mA.

DEVELOPMENT DATA

TYPICAL OPERATING CONDITIONS (ABC electrode at cathode potential)

As 60 kW vision transmitter					notes
Standard	M/G	M/G	M/G		
Channel	14/21	42/42	77/68		
Output power, peak sync.	64	64	64	kW	
Saturated output power	67	67	67	kW	
Beam voltage	25	26	27.5	kV	
Beam current	5.8	5.35	5.5	A	6, 7
Accelerator to cathode voltage	20.7	19.6	20	kV	5
Body current					
without drive	10	8	8	mA	
at 64 kW peak sync., black level	85	65	40	mA	
Focusing coil current	11.5	10.5	10	A	
Drive power, peak sync.	16	8	5	W	8
Sync. efficiency	44.1	46	42.3	%	
Saturated efficiency	46.2	48.1	44.5	%	
Bandwidth at –1 dB points	7	7	7	MHz	9

As 6 kW FM sound transmitter					
Output power	6.5	6.5	6.5	kW	
Beam voltage	25	26	27.5	kV	
Beam current	0.85	0.8	0.8	A	
Accelerator to cathode voltage	5.7	5.5	5.5	kV	5
Focusing coil current	10	9	9	A	
Drive power	5	4	4	W	8
Bandwidth at –1 dB points	1	1	1	MHz	

As 12 kW FM sound transmitter					
Output power	13	13	13	kW	
Beam voltage	25	26	27.5	kV	
Beam current	1.5	1.35	1.5	A	
Accelerator to cathode voltage	8.4	7.8	8.4	kV	7
Focusing coil current	10	9	9	A	
Drive power	5	4	4	W	8
Bandwidth at –1 dB points	1	1	1	MHz	

As 24 kW FM sound transmitter					
Output power	25.5	25.5	25.5	kW	
Beam voltage	25	26	27.5	kV	
Beam current	2.8	2.5	2.5	A	
Accelerator to cathode voltage	12.7	11.8	11.8	kV	7
Focusing coil current	11	10	10	A	
Drive power	5	4	4	W	8
Bandwidth at –1 dB points	1.5	1.5	1.5	MHz	

As 70 kW vision transmitter					notes
Standard	M/G	M/G	M/G		
Channel	14/21	42/42	77/68		
Output power, peak sync.	74	74	74	kW	
Saturated output power	76	76	76	kW	
Beam voltage	26.5	27.7	28.5	kV	
Beam current	6.3	5.8	5.7	A	6, 7
Accelerator to cathode voltage	22	21	20.5	kV	5
Body current					
without drive	12	10	10	mA	
at 74 kW peak sync., black level	80	45	35	mA	
Focusing coil current	11	10	10	A	
Drive power, peak sync.	20	8	5	W	8
Sync. efficiency	44	46	45	%	
Saturated efficiency	45	47	46	%	
Bandwidth at –1 dB points	7	7	7	MHz	9

As 7 kW FM sound transmitter					
Output power	7.5	7.5	7.5	kW	
Beam voltage	26.5	27.7	28.5	kV	
Beam current	1.0	0.85	0.9	A	
Accelerator to cathode voltage	6.4	5.7	6.0	kV	5
Focusing coil current	10	9	9	A	
Drive power	5	4	4	W	8

CW operation for synchrotron radiation sources *		
Frequency	≈ 500	MHz
Output power	63	kW
Beam voltage	26	kV
Beam current	6.5	A
Accelerator to cathode voltage	22.3	kV
Focusing coil current	11.5	A

* For details consult manufacturer.

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ · cm).
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For beam current (tolerance ± 5 %) versus accelerator-to-cathode voltage, see Fig. 4.
7. A voltage divider for adjusting the beam current should be dimensioned on the basis of an accelerator electrode current of typical 2.5 mA. The accelerator electrode should be connected to its supply via a 10 kΩ resistor, designed to withstand the full beam voltage.
8. The drive power is defined as the power delivered to a matched load.
9. Variation of the signal level between black and white at any sideband frequency may cause a reaction of the peak sync. level. Proper tube design limits this reaction to less than 0.5 dB.
10. TE1110B with 1" inlet and steam outlet on top. TE1194B with two 1" tube fittings SWAGELOK SS–1610–1–16 at one side of the cooling jacket.
11. In any case cavity 4 must be equipped with an arc detector. It is recommended to equip also the penultimate cavity (position 3) with an arc detector when the klystron is operated with an output power ≥ 45 kW (vision), ≥ 25 kW (sound).
12. For operation at high altitudes where water boils at lower temperature the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
13. This value applies to transmitters at sea level. At high altitudes the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.

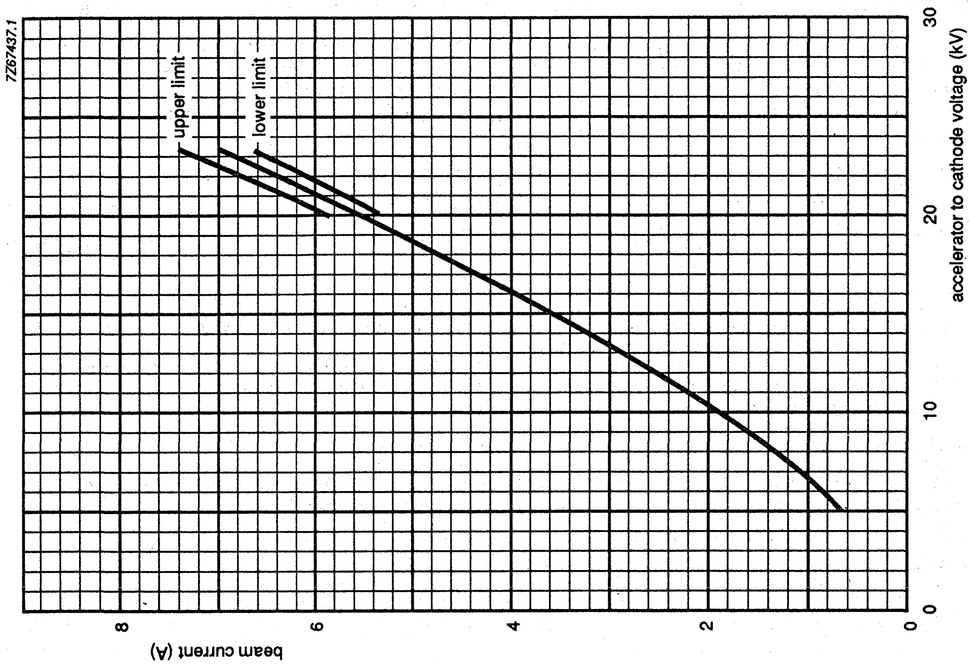


Fig. 4.

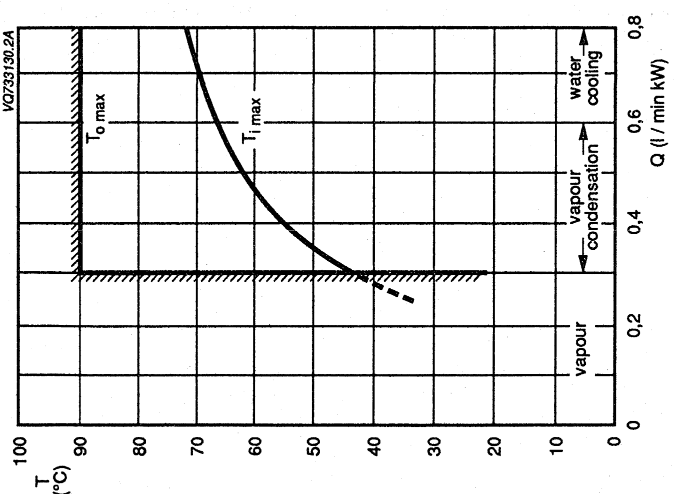


Fig. 3. *

* see note 12

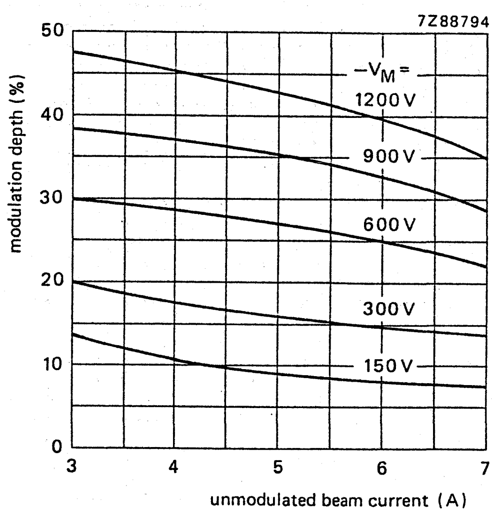


Fig. 5. ABC-operation.
Parameter: modulation voltage $-V_M$
(with respect to cathode).

UHF POWER KLYSTRONS

For UHF band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Complete forced-air cooling
YK 1273 comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.
Continuously tunable external cavities with digital frequency indicators.

QUICK REFERENCE DATA

Frequency range	470 to 860	MHz
Output power as vision transmitter	10 and 15	kW
Cooling	forced air	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

					notes
HEATING: indirect by DC					
Cathode	dispenser type				
Heater voltage	V_f		4.8	V *	
Heater current	I_f	≈	19.5 to 22.5	A	1
Cold heater resistance	R_{fo}	≈	25	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 4.3$ to 4.5 V	t_w	min.	0	s	
FOCUSING					
Focusing coil current			8.5 to 11	A	
Resistance of focusing coils					
cold (20 °C)			7.2 to 9.5	Ω	
operating at an ambient temperature of 20 °C		≤	11	Ω	

BEAM CONTROL for YK 1270 — notes 6, 7
The accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

BEAM CONTROL for YK 1273 — notes 6, 7
The klystron comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 5.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %.

			notes
ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

* The tube must be operated with $V_f = 5.3$ V during the first 600 hours.
During operation the heater voltage may not fluctuate more than +1 or −2%.

MECHANICAL DATA

Dimensions in mm

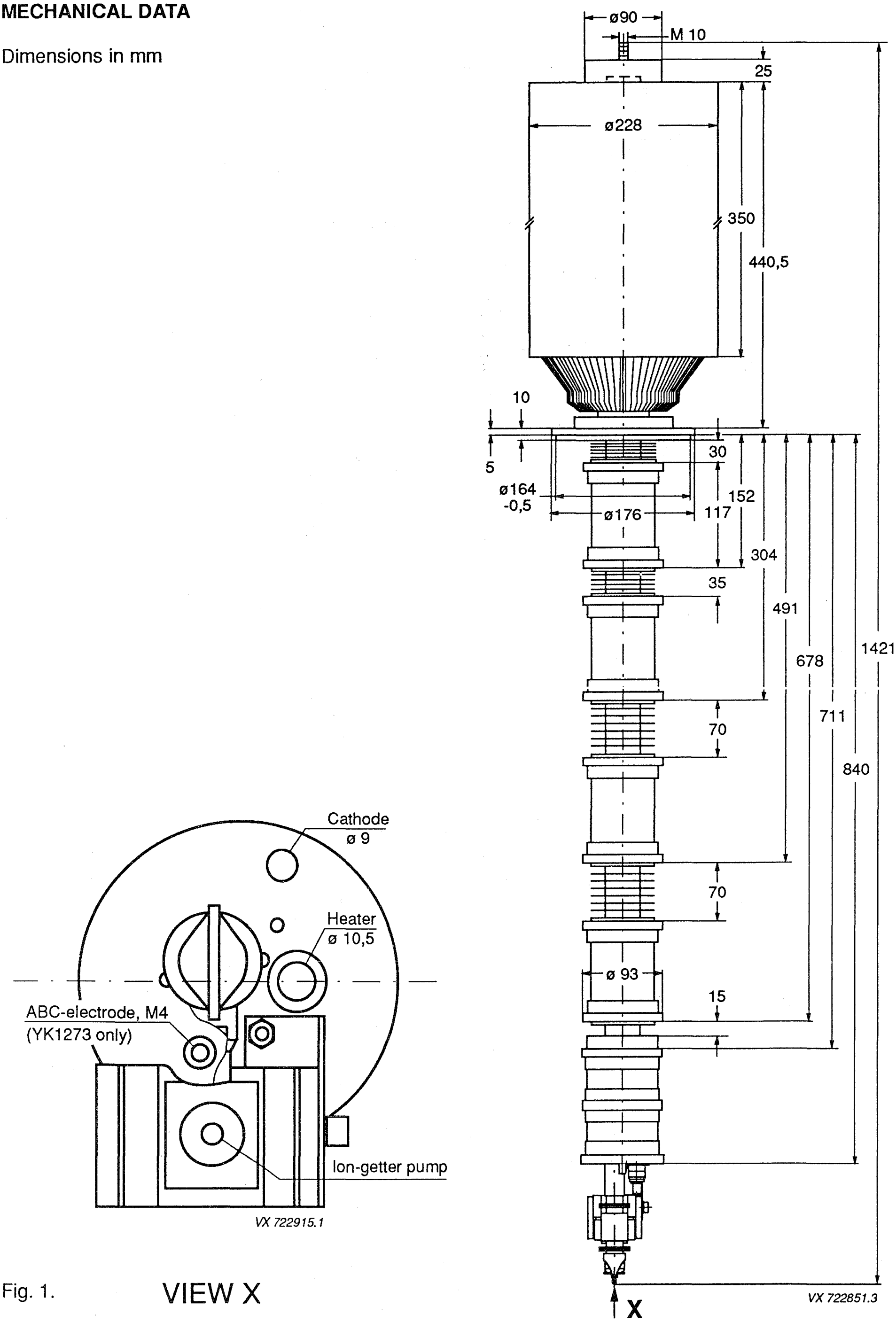


Fig. 1. VIEW X

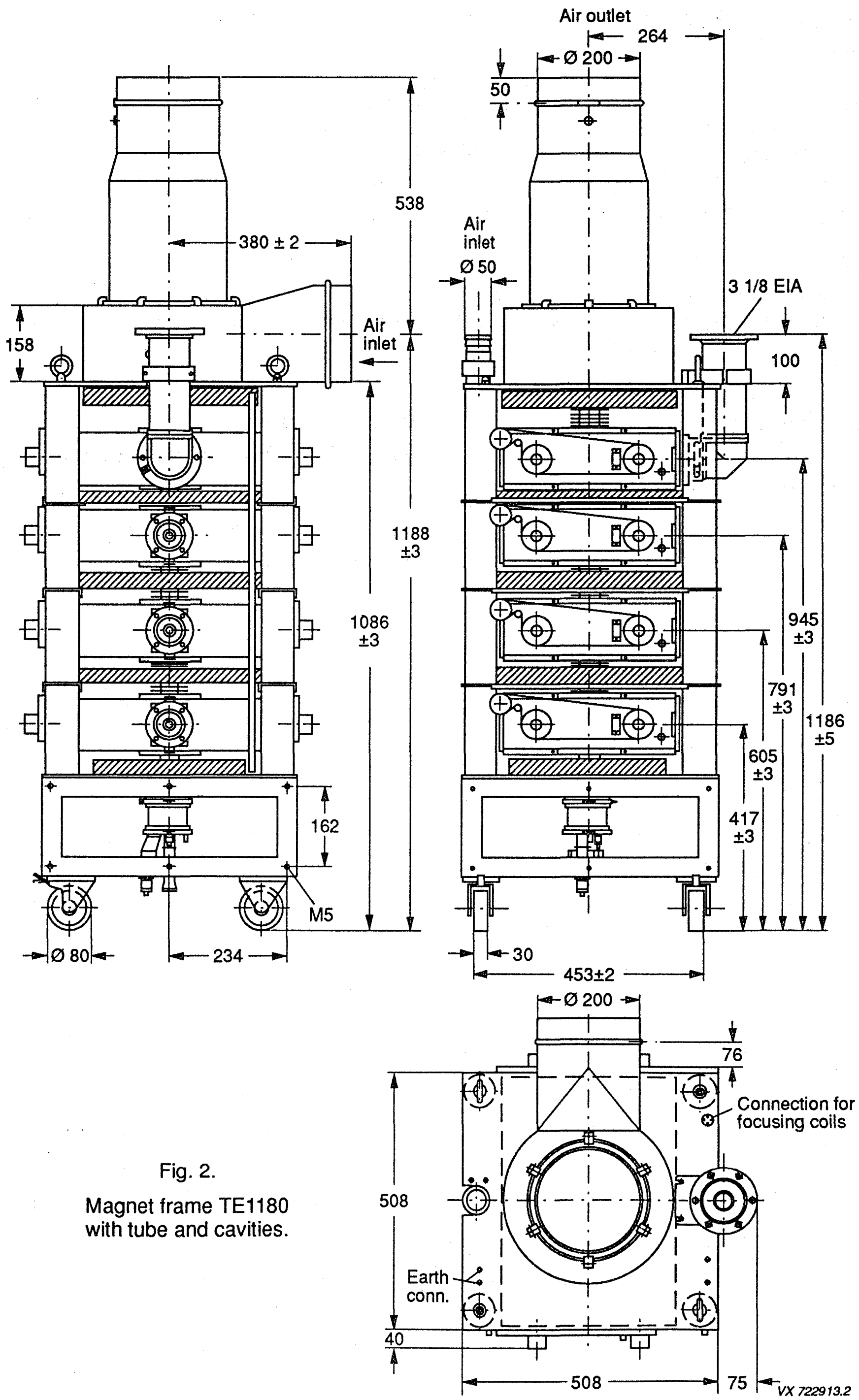


Fig. 2.
Magnet frame TE1180
with tube and cavities.

MASS AND DIMENSIONS

Klystron			
net	approx.	60	kg
gross	approx.	130	kg
outline dimensions of packing (cm)	177 x 58 x 56		
Cavities	approx.	60	kg
Magnet frame with coils	approx.	220	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 2.6 m, excluding hoist, is required.

COOLING

Cavities 1, 2, 3 and 4, drift tubes 4 and 5 and cathode socket	forced air, T_i max. 50 °C, $q \approx 1.2$ m^3/min, $\Delta p = 350$ Pa (3.5 mbar)
Cathode socket only, during black heat	forced air, T_i max. 50 °C, $q \approx 0.15$ m^3/min
Collector	forced air, $q \approx 35$ m^3/min $\Delta p = 2.5$ kPa (25 mbar), note 4

ACCESSORIES

Correct operation can be guaranteed only if approved accessories are used.

Magnet frame with coils	TE1180	
Collector cooling air duct (temperature sensor included)	TE1289	
Set of connectors (heater, cathode, accelerator electrode, ion-getter pump)	TE1184	
Cavities, continuously tunable	4 x TE1285	
Tuning crank (one piece per set)	TE1291	
Tuning knob (one piece per set)	TE1292	
Arc detector	2 x TE1107C	note 11
Input coupler and load coupler for cavities 2 and 3 (optional for front panel drive 3 x TE1226D)	3 x TE1186F	
Output coupler, 3 1/8 inch, 90° elbow	TE1187C	note 12, 13
Tool set	TE1290	

Recommended circulators (optional)

470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

DEVELOPMENT DATA

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible point to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding except for the cathode region. To suppress radiation from the cathode socket the lower part of the trolley TE1180 must be shielded by sheet metal (e.g. 1 mm steel, stainless steel or brass, but not aluminium).

2.RF radiation

RF power may be emitted through apertures other than the normal output coupling (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	6.5	V	
Beam voltage	max.	21	kV	
Cold cathode voltage	max.	–21	kV	
Beam current	max.	3	A	
Accelerator electrode current	max.	5	mA	note 5
Collector dissipation	max.	42	kW	
Load VSWR	max.	1.5		
Temperature				
of tube envelope, except collector	max.	175	°C	
of collector top	max.	200	°C	
Focusing coil current	min.	8.5	A	
	max.	11	A	
ABC-electrode voltage with respect to cathode	max.	–1	kV	

PERFORMANCE DATA

of ABC-electrode for YK1273	min.	typ.	max.	
Capacity	70	75	85	pF
DC current at –1000 V *	-	-	0.5	mA

* The DC electrode current may rise up to max. 1 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 1 mA.

TYPICAL OPERATING CONDITIONS (ABC electrode YK1273 at cathode potential)

As 10 kW vision transmitter

								notes
Standard:	G	I	G	I	G	I		10
Channel	21		45		68			
Output power, peak sync.	11		11		11		kW	
Beam voltage	13	13.5	15	15	16	16	kV	
Beam current	1.95	2.05	1.55	1.55	1.5	1.5	A	6
Accelerator to cathode voltage	≈ 12	≈ 12.5	≈ 10	≈ 10	≈ 10	≈ 10	kV	7
Focusing coil current								
typical	10.0	10.0	9.8	9.8	9.7	9.7	A	
minimum	9.8	9.8	9.6	9.6	9.5	9.5	A	
Drive power, peak sync. max.	10	15	6	10	4	8	W	8
Operating efficiency	43	40	47	47	45	45	%	
Minimum efficiency	42	40	46	44	44	43	%	

Sound transmitter

Output power	1.1		2.2		5.5	kW	
Beam voltage	13	16	13	16	18.5	kV	
Beam current	0.38	0.3	0.5	0.4	0.8	A	6
Accelerator to cathode voltage	≈ 3.5	≈ 3.0	≈ 4.5	≈ 3.5	≈ 6.0	kV	7
Focusing coil current							
typical	9.7		9.7		9.7	A	9
minimum	9.5		9.5		9.5	A	
Drive power,							
channel 21	4		4		4	W	8
channel 45	2		2		2	W	8
channel 68	1		1		1	W	8
Bandwidth at –1 dB points	≥ 300		≥ 300		≥ 300	kHz	
Operating efficiency	22		34		37	%	

DEVELOPMENT DATA

TYPICAL OPERATING CONDITIONS (continued)
(ABC electrode YK1273 at cathode potential)

As 15 kW vision transmitter

								notes
Standard:	G	I	G	I	G	I		10
Channel	21		45		68			
Output power, peak sync.	16.5		16.5		16.5		kW	
Beam voltage	16.5	15.5	17.5	17.5	19	19	kV	
Beam current	2.35	2.6	2.0	2.0	1.95	1.95	A	6
Accelerator to cathode voltage	≈ 13.5	≈ 14.5	≈ 12	≈ 12	≈ 12	≈ 12	kV	7
Focusing coil current								
typical	10.0	10.0	9.8	9.8	9.7	9.7	A	
minimum	9.8	9.8	9.6	9.6	9.5	9.5	A	
Drive power, peak sync. max.	10	15	8	10	6	10	W	8
Operating efficiency	43	43	47	47	45	45	%	
Minimum efficiency	42	40	46	44	44	43	%	

Sound transmitter

Output power	1.65		3.3		kW	
Beam voltage	15.5	19	15.5	19	kV	
Beam current	0.37	0.3	0.63	0.5	A	6
Accelerator to cathode voltage	≈ 3.5	≈ 3.0	≈ 4.5	≈ 4.5	kV	7
Focusing coil current						
typical	9.7		9.7		A	9
minimum	9.5		9.5		A	
Drive power,						
channel 21	4		4		W	8
channel 45	2		2		W	8
channel 68	1		1		W	8
Bandwidth at −1 dB points	≥ 300		≥ 300		kHz	
Operating efficiency	29		34		%	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new preheating time. After min. 10 minutes of stand-by heating time at 4.3 to 4.5 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion-getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. Required filtering of cooling air: 99 % of particles exceeding 1 μm diameter.
5. The accelerator electrode voltage must not be positive with respect to the body (ground).
6. For cathode current versus accelerator-to-cathode voltage, see Fig. 4.
7. The accelerator electrode has to be connected to its supply (power supply or voltage divider) via a 10 kΩ resistor.
   For adjusting the cathode current a voltage divider should be dimensioned according to an accelerator electrode current of max. 1.5 mA.
8. The drive power is defined as the power delivered to a matched load.
9. Value is not critical. It may be set in accordance to the vision klystron focusing coil current. Operation of one vision and one sound klystron focusing unit in series is admitted.
10. Standard I: klystron tuned to frequency response according Fig. 3.

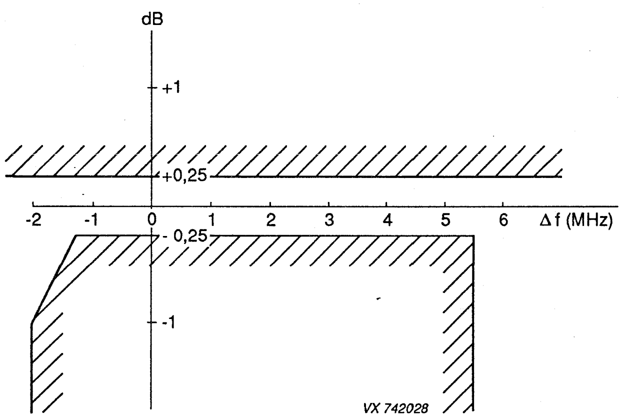


Fig. 3.

11. In any case cavity 4 must be equipped with an arc detector. It is recommended to equip also the penultimate cavity (position 3) with an arc detector when the klystron is operated with an output power ≥ 15 kW (vision), ≥ 8 kW (sound).
12. The output couplers TE1187 comprise a standard loop (Type No 1). For certain channels special (optional) coupling loops are required.

TE1187R (Type No 2)	for vision/sound operation at channel 32/31 (8 MHz raster) resp. 28, 29/28 (6 MHz raster)
TE1187S (Type No 3)	for operation above channel 62 (8 MHz raster) resp. 68 (6 MHz raster)

13. For output power ≤ 10 kW output couplers 1 5/8 inch (TE1187A for front panel control or TE1187B for direct control) are also available.

DEVELOPMENT DATA

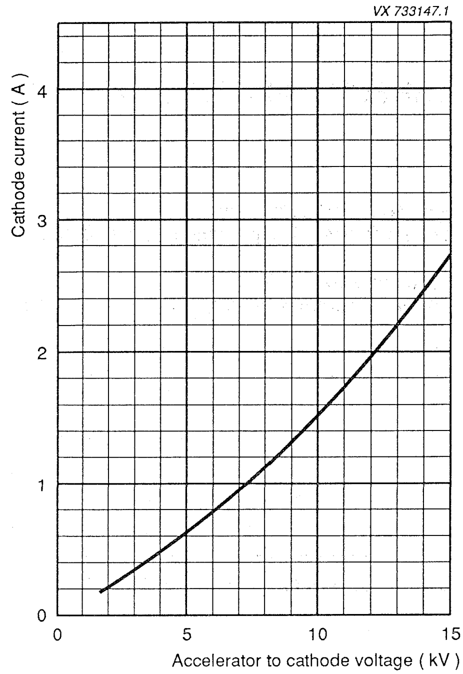


Fig. 4.

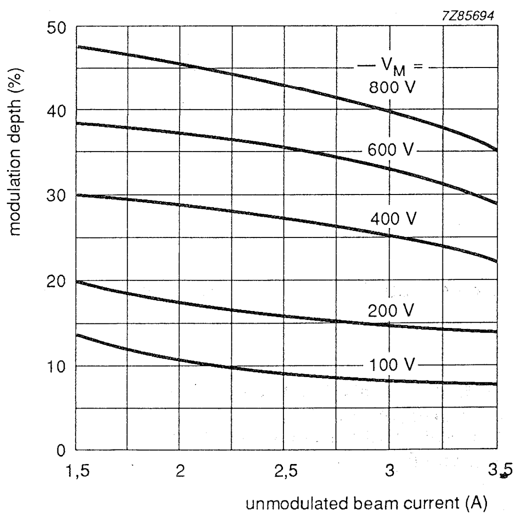


Fig. 5. ABC-operation for YK1273
Parameter: modulation voltage $-V_M$
(with respect to cathode).

UHF POWER KLYSTRONS

For UHF band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
Comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.

QUICK REFERENCE DATA

Frequency range		
YK1290	470 to 610	MHz
YK1291	590 to 720	MHz
YK1292	710 to 860	MHz
Output power as vision transmitter	40	kW
Cooling	vapour, vapour condensation, or water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by DC					notes
Cathode	dispenser type				
Heater voltage	V_f	≈	8.5	V ± 3 %	
Heater current	I_f	≈	22 to 27	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	

FOCUSING: electromagnetic			
Focusing coil current		9 to 12	A
Resistance of focusing coils			
cold (20 °C)		7.2 to 9.5	Ω
operating at an ambient temperature of 20 °C	≤	11	Ω

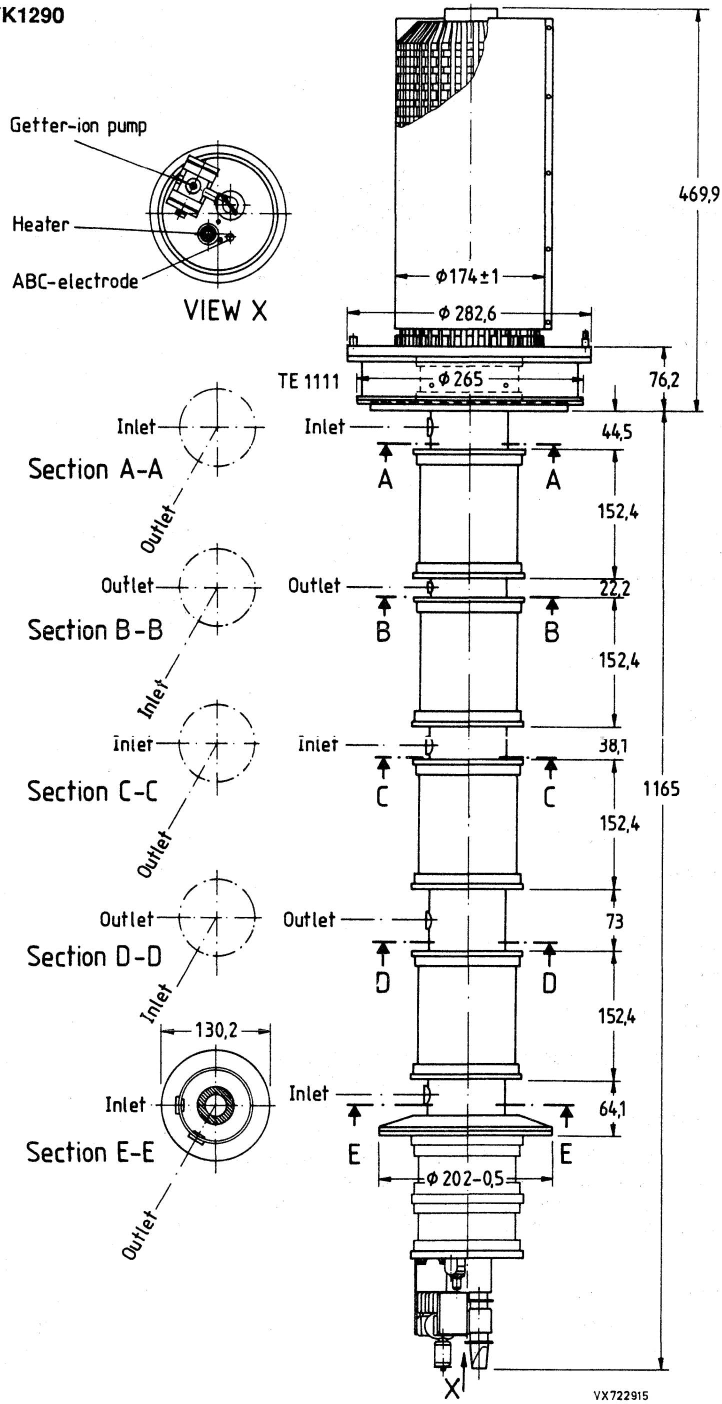
BEAM CONTROL

The klystrons comprise a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 5.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100 %. See Fig. 4.

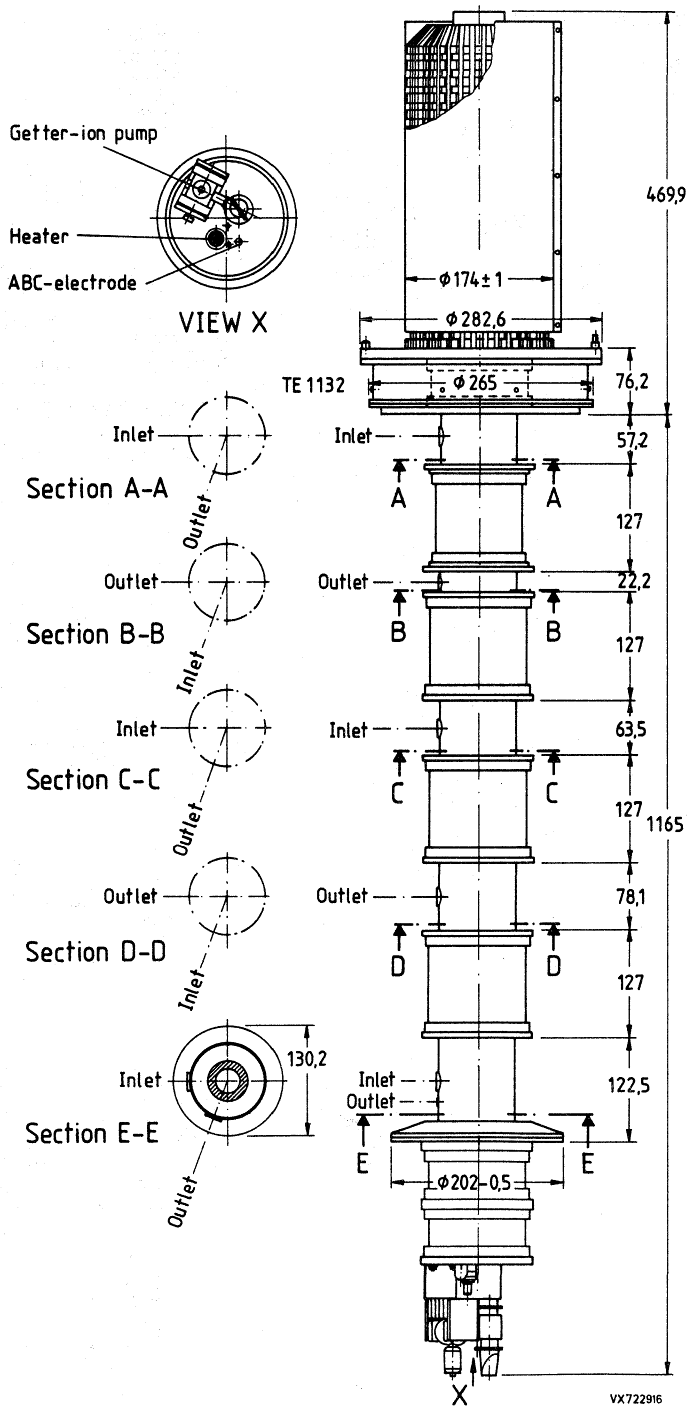
ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

MECHANICAL DATA YK1290

Dimensions in mm

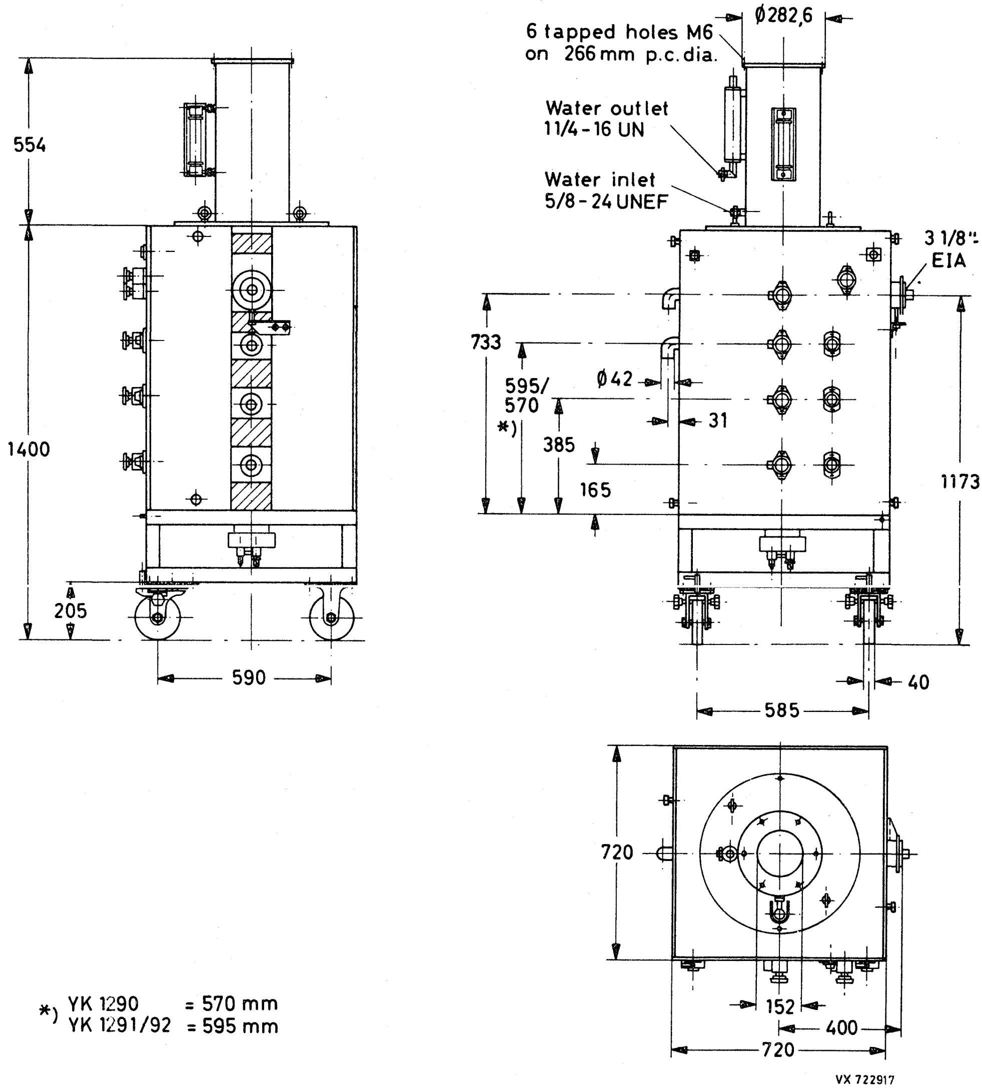


YK1291, YK1292



Mechanical outlines of trolley

Dimensions in mm



*) YK 1290 = 570 mm
YK 1291/92 = 595 mm

COOLING

Cathode socket accelerator electrode	air; q ≈ 0.15 m^3/min, T_i max. 40 °C
Collector	vapour (with boiler TE1110), note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 ℓ/min steam per kW collector dissipation water or vapour condensation (with cooler TE1194) q = 35 to 60 ℓ/min, T_o max 80 °C,
Drift tubes	water; rate of flow to drift tubes and collector connected in series q ≈ 9 ℓ/min, T_i max. 80 °C, Δp = 200 kPa (2 bar)
Cavities 3 and 4	forced air; q = 1.5 m^3/min, Δp = 250 Pa (2.5 mbar) T_i max. 45 °C

MASS AND DIMENSIONS

Klystron			
net	approx.	80	kg
gross	approx.	230	kg
outline dimensions of packing (cm)	205 x 75 x 65		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	885	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3.5 m, excluding hoist, is required.

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

ACCESSORIES (note 5)

A. Accessories required for first equipment

	YK1290	**YK1291**	**YK1292**
Collector radiation suppressor	TE1111	TE1132	TE1195
Accelerator electrode ring	TE1141	TE1141	TE1141
Cathode ring	TE1142B	TE1142B	TE1142B
Set of sealing rings, supplied with each tube	TE1147	TE1147	TE1147
Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Extension pipes for drift tubes	6x TE1133A 2x TE1133B	6x TE1133A 2x TE1133B	6x TE1133A 2x TE1133B
Water interconnecting pipes between drift tubes			
$T_2 - T_2$	TE1134A	TE1135A	TE1135A
$T_2 - T_3$	TE1134B	TE1135B	TE1135B
$T_3 - T_4$	TE1134C	TE1135C	TE1135C
$T_4 - T_5$	TE1134D	TE1135D	TE1135D
Flexible water hose between tube and boiler			
for vapour cooling	TE1145A	TE1145A	TE1145A
between frame and tube	TE1145B	TE1145B	TE1145B
Boiler for vapour cooling	TE1110	TE1110	TE1110
or			
Cooler for water cooling	TE1194	TE1194	TE1194
Cavities	3x TE1121A 1x TE1121D	3x TE1098A 1x TE1098D	3x TE1191A 1x TE1191B
Input coupler	TE1122A	TE1102	TE1102
Load coupler for cavities 2 and 3	2x TE1122B	2x TE1102	2x TE1102
Blanking plates	3x TE1157	3x TE1157	3x TE1157
Output coupler for cavity 4	TE1123	TE1105	TE1196
Arc detector	TE1107	TE1107	TE1107
Magnet frame with coils	TE1108	TE1108	TE1108
Tool set	TE1137	TE1137	TE1137

B. Accessories to be ordered separately when replacing equivalent other brand types

Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146

C. Spare and optional parts	YK1290	YK1291	YK1292
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Set of sealing rings	TE1147	TE1147	TE1147
Water protection shield	TE1139	TE1139	TE1139
Recommended circulators			
470 to 600 MHz	2722 162 01551 (T100/IV-N)		
600 to 800 MHz	2722 162 01561 (T100/V-N)		
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)		

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	23	kV	
Cold cathode voltage	max.	–27	kV	
Beam current	max.	7	A	
Body current	max.	150	mA	
Accelerator electrode current	max.	6	mA	note 7
Collector dissipation	max.	150	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system TE1194B	max.	600	kPa (6 bar)	note 6
ABC-electrode voltage with respect to cathode	max.	–1.4	kV	

PERFORMANCE DATA

of ABC-electrode	min.	typ.	max.	
Capacity	80	90	100	pF
DC current at –1000 V *	-	-	1	mA

* The DC electrode current may rise up to max. 2 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 2 mA.

TYPICAL OPERATING CONDITIONS: YK1290/YK1291 (ABC electrode at cathode potential)

As 40 kW vision transmitter (standard G)

	gain-tuned operation	efficiency-tuned operation (examples)			
Output power, peak sync.	45	45	45	kW	
Beam voltage	22	20.5	22	kV	
Beam current	6.3	5.7	4.8	A	note 8
Accelerator to cathode voltage	22	20.5	18	kV	
Body current					
without drive	15	15	15	mA	
at 45 kW peak sync., black level	30	40	40	mA	
Focusing coil current	10.5	10.5	10.0	A	
Drive power, peak sync.					
YK1290 - channel 21	2	10	6	W	note 9
channel 38	1.5	7	4	W	note 9
YK1291 - channel 37	1.5	7	4	W	note 9
channel 51	1	5	3	W	note 9
Bandwidth at −1 dB points	8	8	8	MHz	note 10
Differential gain	80	75	70	%	note 11
Differential phase	6	7	10	deg	note 11
Linearity	70	65	60	%	note 12
Operating efficiency	32	38.5	42.5	%	
Saturation output power	55	60	46.5	kW	
Saturation efficiency	40	43	44	%	

As 4 kW/8 kW sound transmitter (standard G)

Output power	4.5	9	4.5	9	kW	
Beam voltage	20.5	20.5	22	22	kV	
Beam current	1.25	1.5	1.15	1.4	A	note 8
Accelerator cathode voltage	≈ 7.5	≈ 8.5	≈ 7	≈ 8	kV	note 13
Focusing coil current	9				A	
Drive power	1.5				W	note 9
Bandwidth at −1 dB points	1				MHz	

TYPICAL OPERATING CONDITIONS: YK1292 (ABC electrode at cathode potential)

As 40 kW vision transmitter **(standard G)**

Output power, peak sync.	45	kW	
Beam voltage	23	kV	
Beam current	4.6	A	note 8
Accelerator to cathode voltage	18	kV	
Body current			
without drive	15	mA	
at 45 kW peak sync., black level	40	mA	
Focusing coil current	10	A	
Drive power, peak sync.	2	W	note 9
Bandwidth at −1 dB points	8	MHz	note 10
Differential gain	70	%	note 11
Differential phase	10	deg	note 11
Linearity	60	%	note 12
Operating efficiency	42.5	%	
Saturation output power	46.5	kW	
Saturation efficiency	44	%	

As 4 kW/8 kW sound transmitter **(standard G)**

Output power	4.5	9	kW	
Beam voltage	23	23	kV	
Beam current	1.1	1.3	A	note 8
Accelerator to cathode voltage	≈ 7	≈ 8	kV	note 13
Focusing coil current	9		A	
Drive power	1.5		W	note 9
Bandwidth at −1 dB points	1		MHz	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new waiting time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ·cm).
5. Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used. The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially admissible, non-dangerous level the tube must be shielded and any possible radiation path must be blocked by at least 1 mm of brass or an equivalent portion of non-magnetic X-ray absorbing material. The proper use of our accessory parts will provide the necessary shielding.
6. Static pressure in the body-cooling system and in the water-cooling jacket TE1194.
7. The accelerator electrode voltage must not be positive with respect to the body (ground).
8. If the accelerator electrode is connected to the body (ground) via 10 kΩ resistor, the beam current is within ± 5% of the value given in the graph of Fig. 4.
9. The drive power is defined as the power delivered to a matched load.
10. Variation of the signal level between black and white at any sideband frequency may cause a reaction of the peak sync. level. Proper tube design limits this reaction to less than 0.5 dB.
11. Measured with a sawtooth signal from black level to peak white occuring at each line and superimposed colour subcarrier with a 10 % peak to peak amplitude.
12. Measured with a ten-step staircase signal from black level to peak with occuring at each line.
13. A voltage divider for adjusting the beam current should be dimensioned on the basis of an accelerator electrode current of max. 1.5 mA.

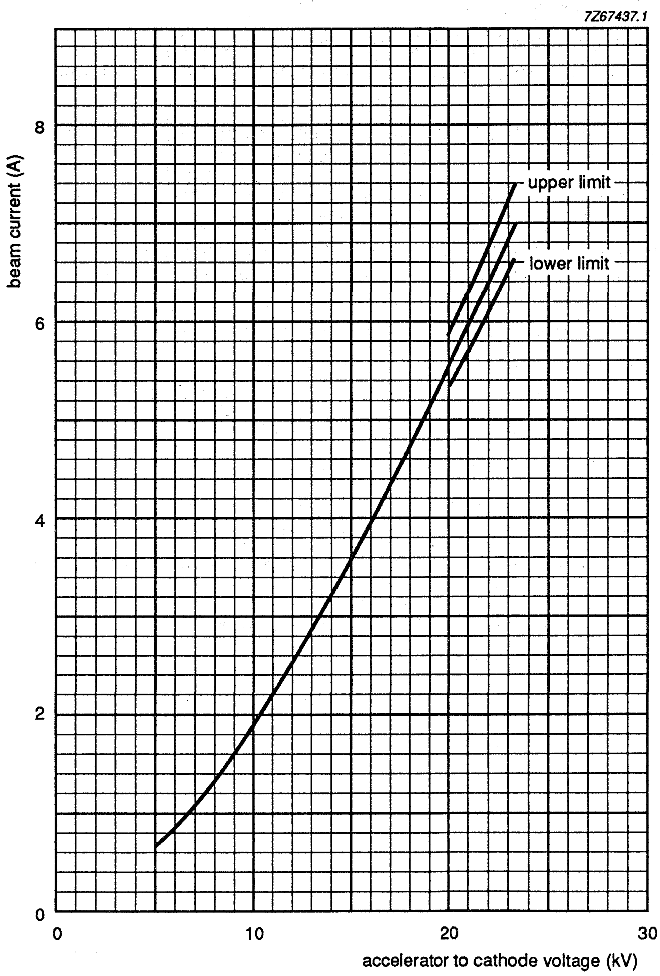


Fig. 4 Beam current as a function of accelerator to cathode voltage (ABC electrode at cathode potential).

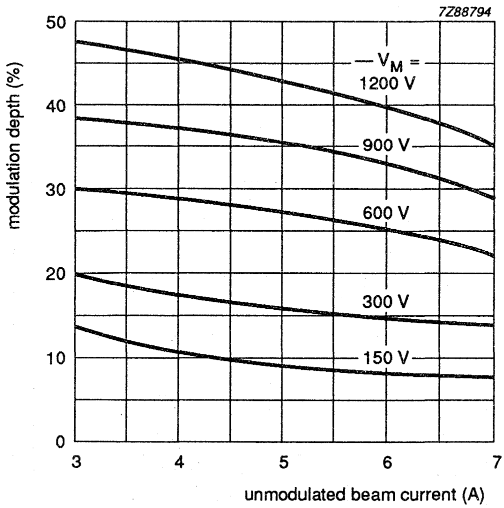


Fig. 5. ABC-operation.
Parameter: modulation voltage $-V_M$
(with respect to cathode).

U.H.F. POWER KLYSTRONS

For u.h.f. band IV/V vision transmitters and sound transmitters.
Metal-ceramic construction, four external cavities, electromagnetic focusing and a high-stability dispenser type cathode.
Suitable for vapour, vapour-condensation or water cooling.
Comprising a non-intercepting annular beam control electrode (ABC) for low-voltage beam modulation.

QUICK REFERENCE DATA

Frequency range		
YK1295	470 to 610	MHz
YK1296	590 to 720	MHz
YK1297	710 to 860	MHz
Output power as vision transmitter	40 and 55	kW
Cooling	vapour, vapour condensation, or water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by DC					notes
Cathode	dispenser type				
Heater voltage	V_f	≈	8.5	V ±3 %	
Heater current	I_f	≈	22 to 27	A	1
Cold heater resistance	R_{fo}	≈	30	mΩ	
Preheating time					2
from cold, $V_f = 0$ V	t_w	min.	300	s	
from black heat, $V_f = 6$ V	t_w	min.	0	s	

FOCUSING: electromagnetic			
Focusing coil current		9 to 12	A
Resistance of focusing coils			
cold (20 °C)		7.2 to 9.5	Ω
operating at an ambient temperature of 20 °C	⩽	11	Ω

BEAM CONTROL

The klystron comprises a non-intercepting annular beam control (ABC) electrode for low-voltage beam modulation. See Fig. 5.
Additionally the accelerator electrode voltage allows adjustment of the beam current between 0 and 100%.

ION-GETTER PUMP SUPPLY			3
Pump voltage, no-load condition	3 to 4	kV	
Internal resistance of supply	300	kΩ	

MECHANICAL DATA YK1295

Dimensions in mm

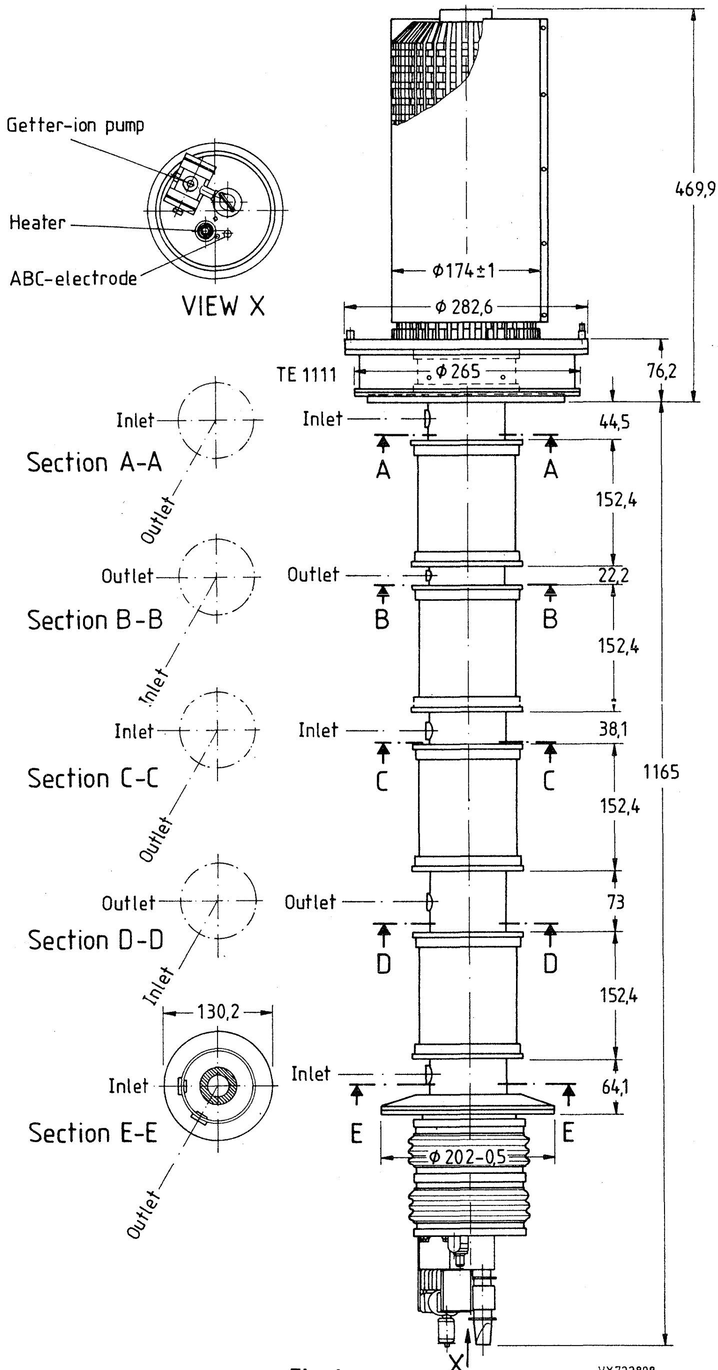


Fig. 1.

YK1296, YK1297

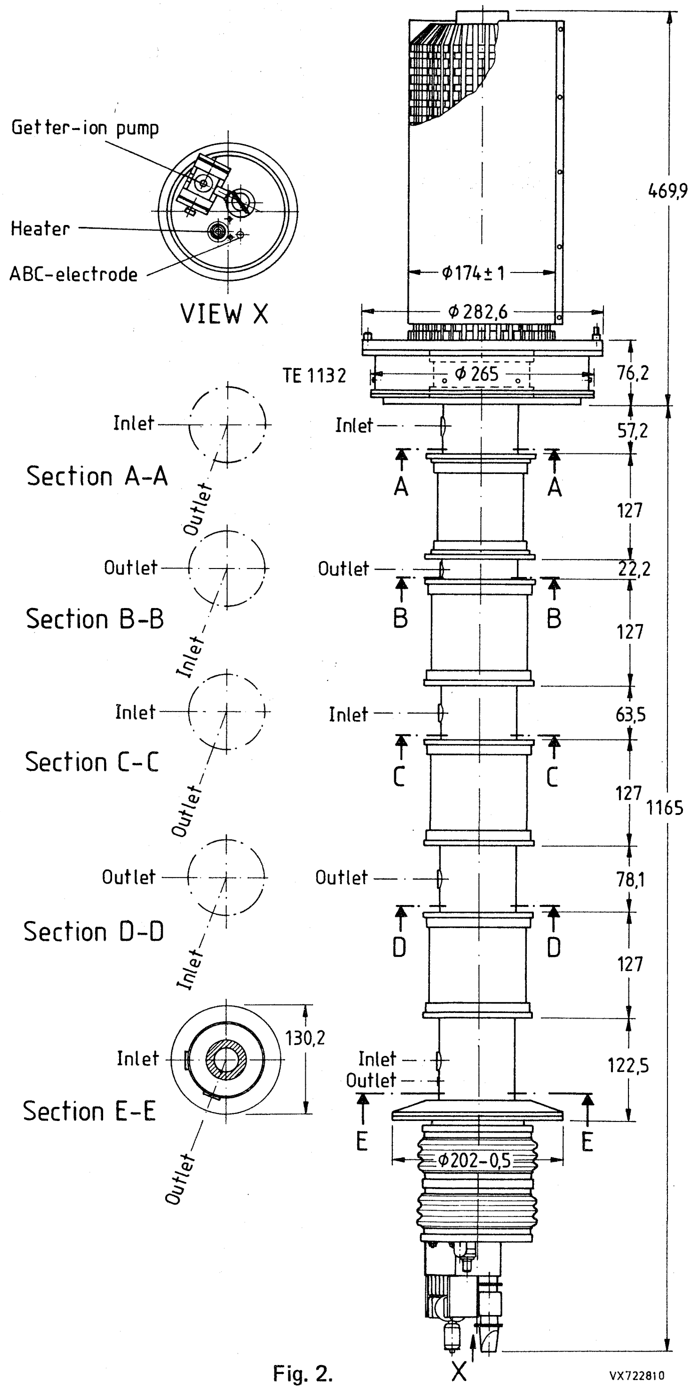


Fig. 2.

Mechanical outlines of trolley

Dimensions in mm

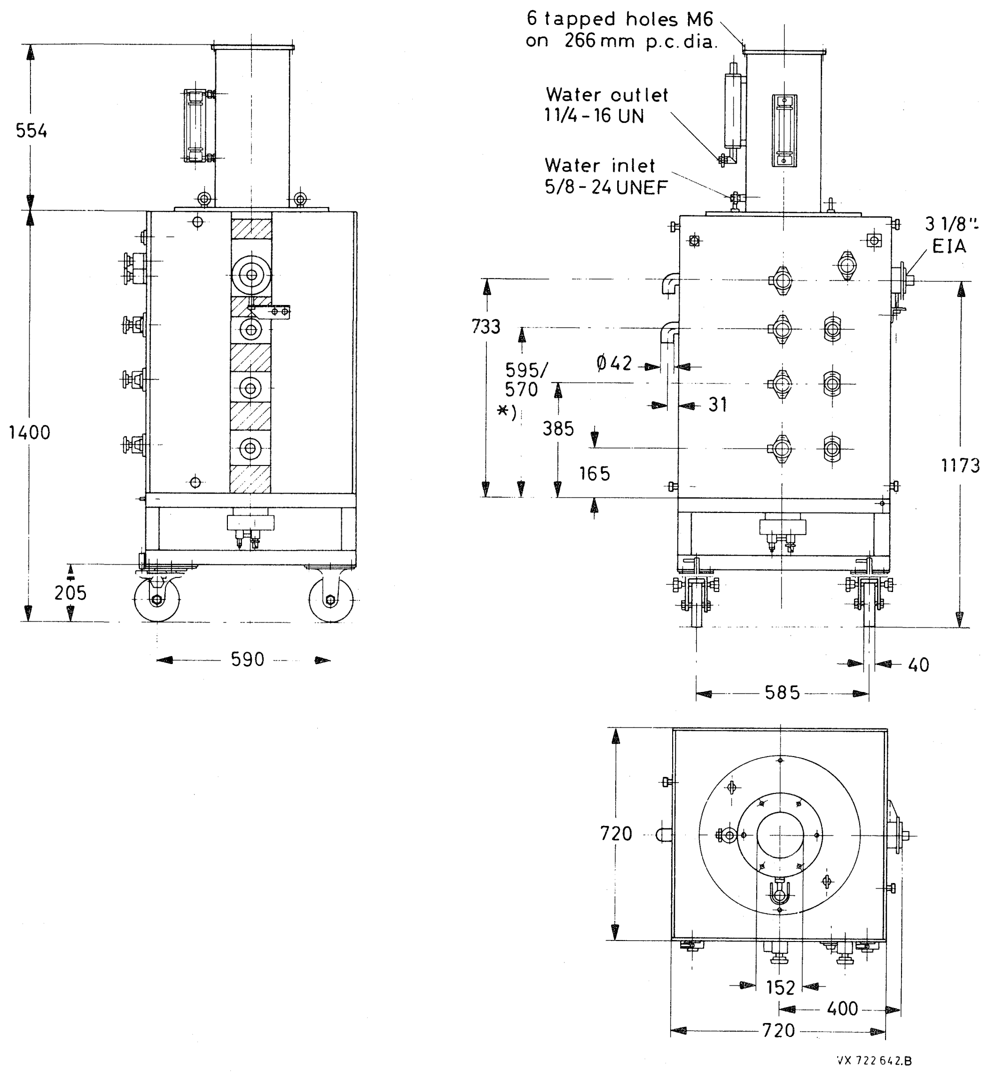


Fig. 3.

* YK1295 = 570 mm.
YK1296/1297 = 595 mm.

COOLING

Cathode socket accelerator electrode	air; q ≈ 0.15 m^3/min, T_i max. 40 °C
Collector	vapour (with boiler TE1110), note 4 volume of water converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 ℓ/min steam per kW collector dissipation water or vapour condensation (with cooler TE1194) q = 35 to 60 ℓ/min, T_o max 80 °C,
Drift tubes	water; rate of flow to drift tubes and collector connected in series q ≈ 9 ℓ/min, T_i max. 80 °C, Δp = 200 kPa (2 bar)
Cavities 3 and 4	forced air; q = 1.5 m^3/min, Δp = 250 Pa (2.5 mbar) T_i max. 45 °C

MASS AND DIMENSIONS

Klystron			
net	approx.	80	kg
gross	approx.	230	kg
outline dimensions of packing (cm)	182 x 75 x 75		
Cavities	approx.	45	kg
Magnet frame with coils	approx.	885	kg

MOUNTING

Mounting position: vertical with collector up.
To remove the tube from the magnet frame a total free height of 3.5 m, excluding hoist, is required.

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

Instruction manual

For detailed mounting and tuning instructions see klystron instruction manual, delivered with each tube.

ACCESSORIES (note 5)

A. Accessories required for first equipment

	YK1295	YK1296	YK1297
Collector radiation suppressor	TE1111	TE1132	TE1195
Accelerator electrode ring	TE1141	TE1141	TE1141
Cathode ring	TE1142B	TE1142B	TE1142B
Set of sealing rings, supplied with each tube	TE1147	TE1147	TE1147
Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Extension pipes	6x TE1133A	6x TE1133A	6x TE1133A
for drift tubes	2x TE1133B	2x TE1133B	2x TE1133B
Water interconnecting pipes between drift tubes			
$T_2 - T_2$	TE1134A	TE1135A	TE1135A
$T_2 - T_3$	TE1134B	TE1135B	TE1135B
$T_3 - T_4$	TE1134C	TE1135C	TE1135C
$T_4 - T_5$	TE1134D	TE1135D	TE1135D
Flexible water hose			
between tube and boiler for vapour cooling	TE1145A	TE1145A	TE1145A
between frame and tube	TE1145B	TE1145B	TE1145B
Boiler for vapour cooling	TE1110	TE1110	TE1110
or			
Cooler for water cooling	TE1194	TE1194	TE1194
Cavities	3x TE1121A	3x TE1098A	3x TE1191A
	1x TE1121D	1x TE1098D	1x TE1191B
Input coupler	TE1122A	TE1102	TE1102
Load coupler for cavities 2 and 3	2x TE1122B	2x TE1102	2x TE1102
Blanking plates	3x TE1157	3x TE1157	3x TE1157
Output coupler for cavity 4	TE1123	TE1105	TE1196
Arc detector	TE1107	TE1107	TE1107
Magnet frame with coils	TE1108	TE1108	TE1108
Tool set	TE1137	TE1137	TE1137

B. Accessories to be ordered separately when replacing equivalent other brand types

	YK1295	YK1296	YK1297
Magnet flux ring	TE1138	TE1138	TE1138
Spark gap	TE1140	TE1140	TE1140
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146

C. Spare and optional parts	YK1295	YK1296	YK1297
Set of connectors (heater, cathode, acc. electrode, ion-getter pump)	TE1146	TE1146	TE1146
Set of sealing rings	TE1147	TE1147	TE1147
Water protection shield	TE1139	TE1139	TE1139

Recommended circulators	
470 to 600 MHz	2722 162 01551 (T100/IV-N)
600 to 800 MHz	2722 162 01561 (T100/V-N)
790 to 1000 MHz	2722 162 03261 (T100/V-3-N)

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	9.5	V	
Beam voltage	max.	28	kV	
Cold cathode voltage	max.	–30	kV	
Beam current	max.	7	A	
Body current	max.	150	mA	
Accelerator electrode current	max.	6	mA	note 7
Collector dissipation	max.	150	kW	
Load VSWR	max.	1.5		
Temperature of tube envelope	max.	175	°C	
Static pressure in the cooling system	max.	600	kPa	(6 bar) note 6
ABC-electrode voltage with respect to cathode	max.	–1.4	kV	

PERFORMANCE DATA

of ABC-electrode	min.	typ.	max.	
Capacity	80	90	100	pF
DC current at – 1000 V*	–	–	1	mA

* The d.c. electrode current may rise up to max. 2 mA during life time. The applied modulator should be designed for an ABC-electrode current of at least 2 mA.

TYPICAL OPERATING CONDITIONS

As 55 kW/40 kW vision transmitter (standards: M, M* and G)

			YK1295/YK1296			YK1297				
Output power, peak sync.			58	58	45	58	58	45	kW	
Beam voltage			22.5	26	22.5	23.5	27	25.5	kV	
Beam current			6.4	4.85	3.8	5.9	4.9	3.9	A	note 8
Accelerator to cathode voltage			≈22.5	≈18.5	≈16	≈21	≈19	≈16	kV	
Body current										
without drive			15	15	15	15	15	15	mA	
at black level			40	40	40	40	40	40	mA	
Focusing coil current			10.5	10.5	9.5	10.5	10.5	10	A	
Drive power, peak sync.										
Standard	M	G								
YK1295 - channel	14	21	10	6	6	–	–	–	W	note 9
channel	37	38	7	4	4	–	–	–	W	note 9
YK1296 - channel	37	36	7	4	4	–	–	–	W	note 9
channel	52	51	5	3	3	–	–	–	W	note 9
YK1297			–	–	–	2	2	2	W	note 9
Bandwidth at –1 dB points			8	8	8	8	8	8	MHz	note 10
Differential gain			75	70	70	70	70	70	%	note 11
Differential phase			6	10	10	10	10	10	deg	note 11
Linearity			65	60	60	60	60	60	%	note 12
Operating efficiency			40	46	46.5	42	44	45	%	
Saturation output power			63	60	46.5	60	60	46.5	kW	
Saturation efficiency			44	47.5	48	43	45	46.5	%	
As 11 kW/8 kW FM sound transmitter										
Output power			12	12	9	12	12	9	kW	
Beam voltage			22.5	26	25.5	23.5	27	25.5	kV	
Beam current			1.5	1.2	1.3	1.5	1.2	1.3	A	
Accelerator cathode voltage			8.5	7.5	≈ 8	8.5	7.5	≈ 8	kV	note 13
Focusing coil current			9	9	9	9	9	9	A	
Drive power			1.5	1.5	1.5	1.5	1.5	1.5	W	note 9
Bandwidth at –1 dB points			1	1	1	1	1	1	MHz	

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. In case of a mains failure an interruption up to 30 s can be tolerated without new waiting time. After min. 10 minutes of stand-by heating time at 6 V (black heat), the beam current may be switched on; the heater voltage must be increased to its nominal value of 8.5 V simultaneously. Continuous black heat periods should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. To ensure that the klystron is always ready for operation, operate the ion getter pump at least every 6 months (preferably every 3 months) during storage. For details see klystron instruction manual.
4. In order to avoid corrosion of the cooling system, coolant water must be pure and deionized (resistivity min. 100 kΩ·cm).
5. Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used. The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially admissible, non-dangerous level the tube must be shielded and any possible radiation path must be blocked by at least 1 mm of brass or an equivalent portion of non-magnetic X-ray absorbing material. The proper use of our accessory parts will provide the necessary shielding.
6. Static pressure in the body-cooling system and in the water-cooling jacket TE1194.
7. The accelerator electrode voltage must not be positive with respect to the body (ground).
8. If the accelerator electrode is connected to the body (ground) via 10 kΩ resistor, the beam current is within ± 5% of the value given in the graph of Fig. 4.
9. The drive power is defined as the power delivered to a matched load.
10. Variation of the signal level between black and white at any sideband frequency may cause a reaction of the peak sync. level. Proper tube design limits this reaction to less than 0.5 dB.
11. Measured with a sawtooth signal from black level to peak white occuring at each line and superimposed colour subcarrier with a 10 % peak to peak amplitude.
12. Measured with a ten-step staircase signal from black level to peak with occuring at each line.
13. A voltage divider for adjusting the beam current should be dimensioned on the basis of an accelerator electrode current of max. 1.5 mA.

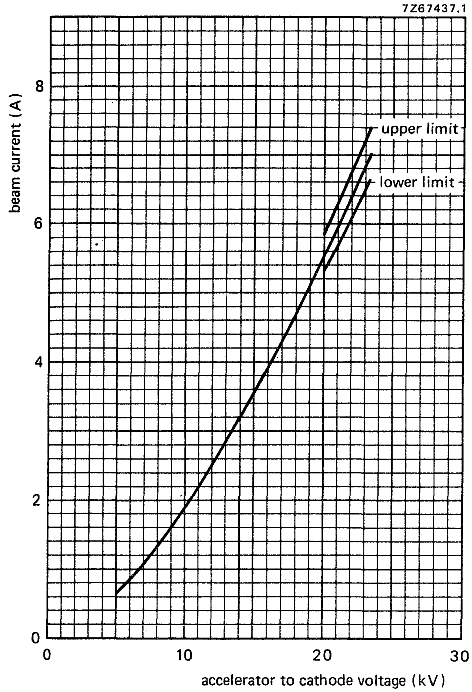


Fig. 4.

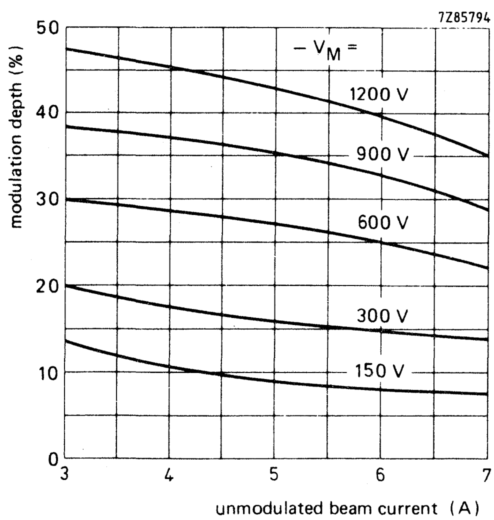


Fig. 5 ABC-operation.
Parameter: modulation voltage $-V_M$
(with respect to cathode).

CONTINUOUS-WAVE HIGH-POWER KLYSTRONS

Water cooled, high efficiency, fixed frequency, continuous-wave high-power klystrons in metal-ceramic construction, for use in scientific and industrial applications. The tubes have internal cavities, solenoid focusing, beam control by accelerator anode and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	499.7	MHz
Bandwidth at saturation (−1 dB points)	2	MHz
Output power		
YK1300	500 to 600	kW
YK1301	600 to 800	kW
YK1305	⩽ 350	kW
Cooling	water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c. or d.c.

Cathode — dispenser type

		min.	typ.	max.		
Heater voltage	V_f	22	25	27	V	
Heater current	I_f	20	23	25	A	notes 1, 2
Cold heater resistance	R_{fo}	–	100	–	mΩ	
Waiting time	t_w	15	–	–	minutes	

FOCUSING: electromagnetic

	min.	typ.	max.	
Solenoid current	7	9	15	A
Solenoid voltage	–	140	220	V
Solenoid resistance	–	15	–	Ω

ION-GETTER PUMP SUPPLY

	min.	typ.	max.	
Operating voltage	3	3.3	4	kV
Operating current	–	10^{-3}	80	mA
Internal resistance of power supply	25	300	–	kΩ

* YK1300 MAINTENANCE TYPE

MECHANICAL DATA

Dimensions in mm

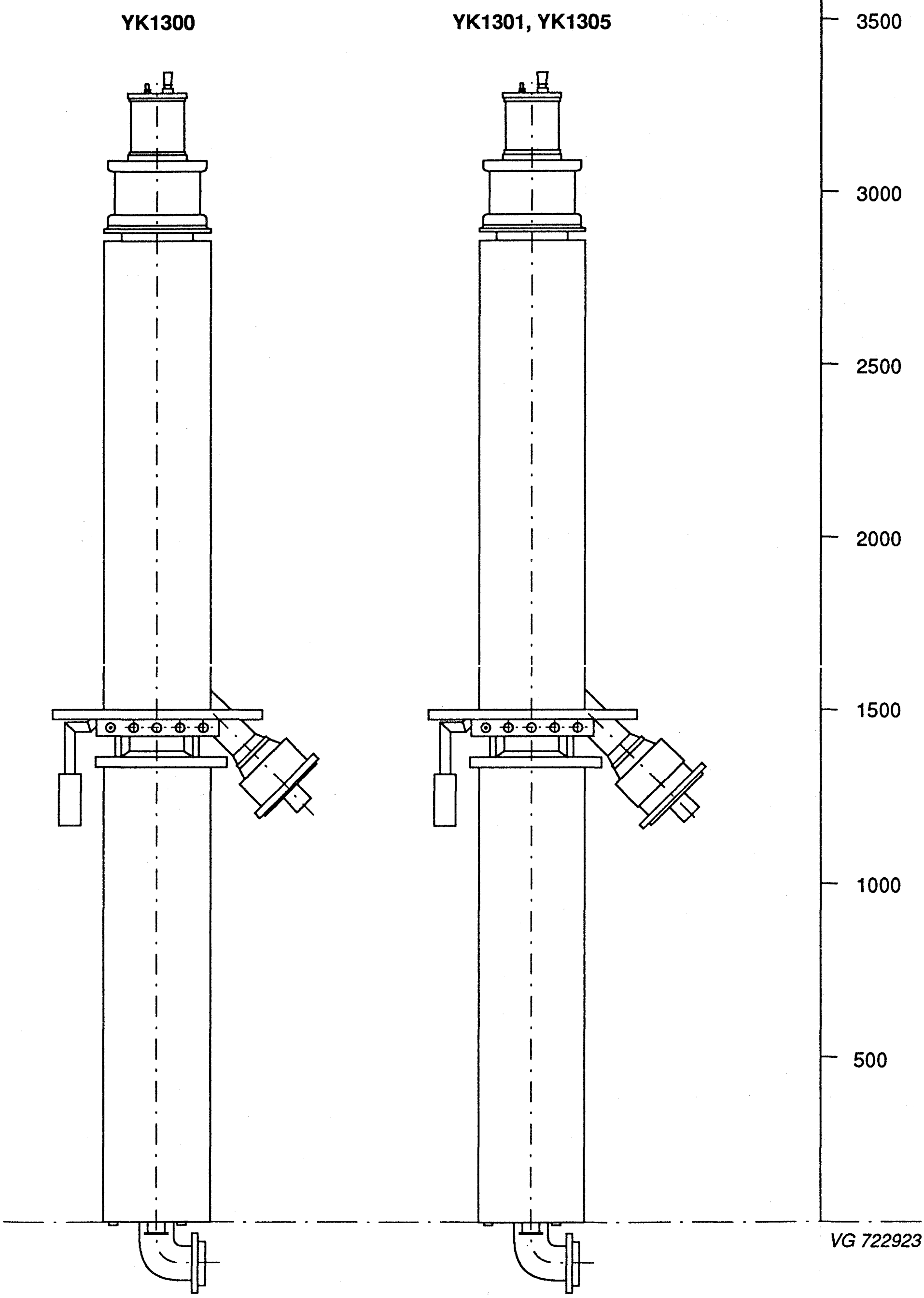


Fig. 1.

MECHANICAL DATA (continued)

Tube mounted in the mounting frame with solenoid.
Dimensions in mm

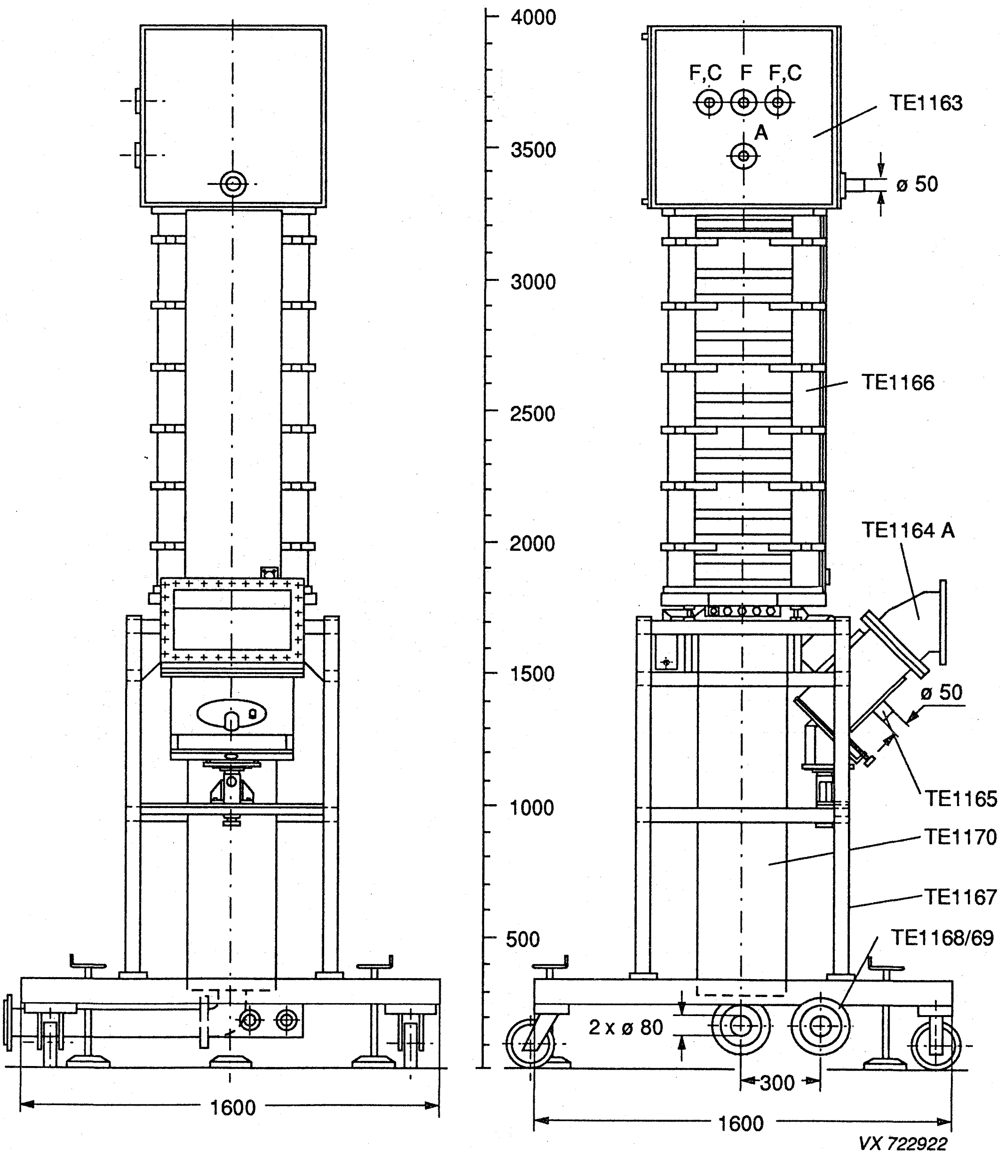


Fig. 2.

MECHANICAL DATA (continued)

Tube mounted in the mounting frame with solenoid.
Dimensions in mm

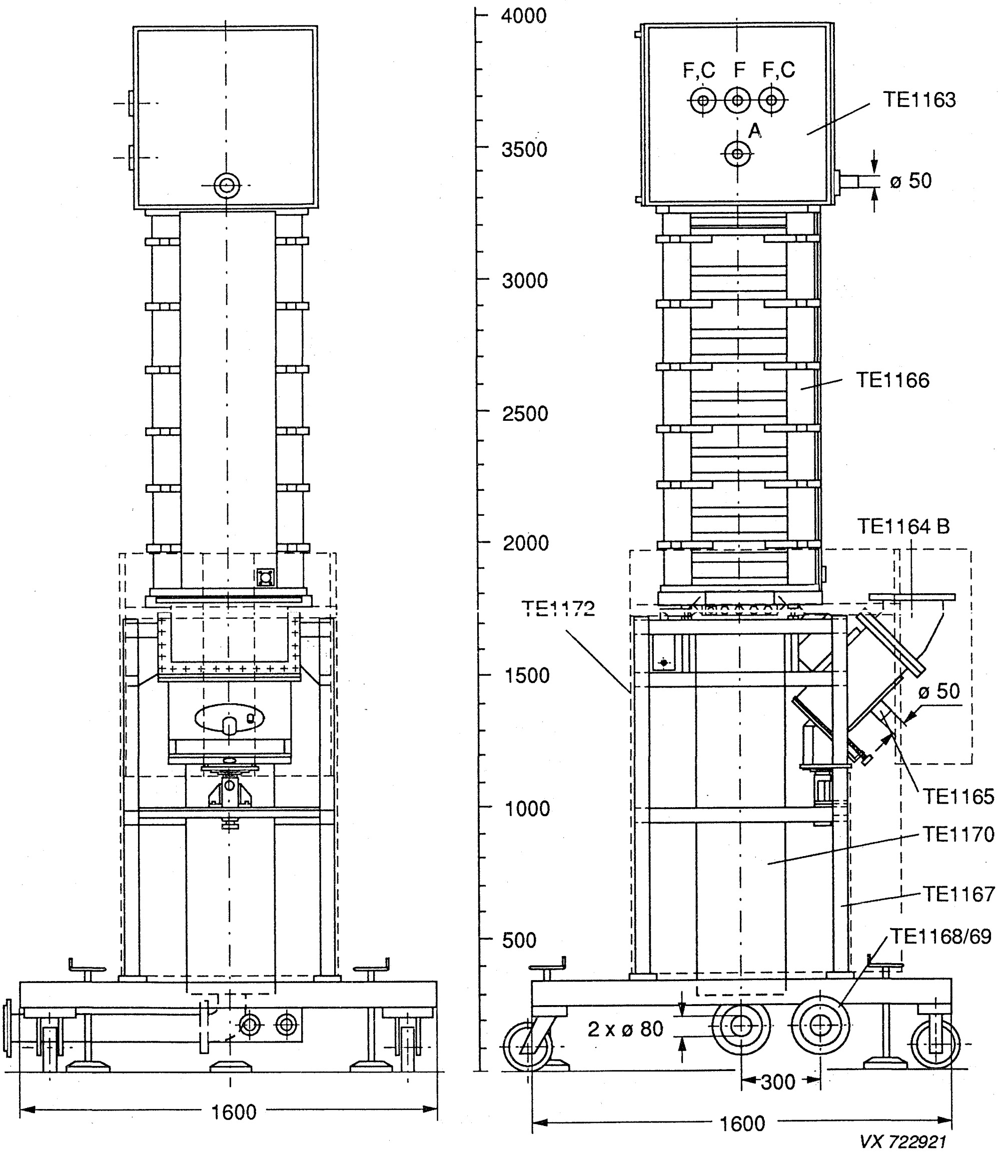


Fig. 3.

Contours of lead shielding TE1172 are indicated in dashed lines.

COOLING

	min.	typ.	max.		
Collector					
demineralized or distilled water with 10% stabilized glycol added					
YK1300, YK1301	750	900	1000	ℓ/min	note 3
YK1305	200	500	700	ℓ/min	note 3
pressure drop	–	200	–	kPa	(= 2 bar)
Body circuit I					
demineralized or distilled water with 10% stabilized glycol added	7	10	–	ℓ/min	note 3
pressure drop	–	300	–	kPa	(= 3 bar)
Body circuit II					
demineralized or distilled water with 10% stabilized glycol added					
YK1300, YK1301	20	25	–	ℓ/min	
YK1305	15	18	–	ℓ/min	note 3
pressure drop	–	300	–	kPa	(= 3 bar)
Cathode socket and accelerator anode					
air	2	–	–	m^3/min	
pressure drop	–	–	500	Pa	(= 5 mbar)
Output window					
air	0.6	1.2	–	m^3/min	
pressure drop	–	9	–	kPa	(= 90 mbar)
Inlet water temperature	–	–	+50	^oC	
Inlet air temperature	–	–	+45	^oC	

MASS

Net mass YK1300, YK1301, YK1305	400	kg
Mounting frame with solenoid	800	kg
Lead shielding	400	kg
Capability of hoist	min. 600	kg

DIMENSIONS

Tube and mounting frame — see drawings

Required ground clearance for lifting hoist — min. 580 cm

MOUNTING

vertical, cathode up

R.F. CONNECTORS

Input — N-type, female

Output — waveguide R5 (WR1800)
mating flange CPR1800
(non-standard, see Fig. 4)

ACCESSORIES

A. Tube parts

Collector water cooling jacket			note 4
Waveguide coupling iris			note 4
Magnet for ion-getter pump (factory fitted)			

B. Operational parts for first equipment

Coaxial/waveguide transition, WR 1800 with 45° elbow			
YK1300		TE1164A	note 5
YK1301, YK1305		TE1164B	note 5
Window cooling air inlet		TE1165	
Accelerator anode ring (factory fitted)		TE1173	
Cathode ring		TE1174A	
Corona protector		TE1174B	
HV connection unit with R3 sockets		TE1163	note 6
Klystron trolley with waveguide support		TE1167	
Focusing coil unit		TE1166	
Water outlet collecting tube		TE1168	
Set of interconnecting water hoses		TE1169	
Connection cables,			
heater/cathode	2x	TE1171A	
heater		TE1171B	
Accelerator anode		TE1171C	
Lead shielding		TE1172	

C. Optional parts

HV socket R3	4x	TE1158	note 7
HV cable with R3 plugs,			
length 6 m	4x	TE1159	note 7
length 9 m	4x	TE1160	note 7
HV dummy plug R3	4x	TE1161	note 7
Collector water cooling jacket		TE1170	

D. Parts for handling

			note 8
Yoke for lifting TE1166 and TE1163		TE1175	
Yoke for lifting and turning a klystron from any position		TE1176	
Supporting frame for storage and any movement of burnt-out or spare klystrons in any position other than vertical		TE1177	
Trolley for transportation of a klystron in horizontal position without lifting gear		TE1178	

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 10% above specified values			
Cathode voltage to body (ground)	max.	−65	kV	
Cold cathode voltage to body (ground)	max.	−75	kV	
Cathode current	max.	18	A	
Accelerator anode voltage to cathode	max.	55	kV	note 9
Cold accelerator anode voltage to cathode	max.	65	kV	
Accelerator anode current	max.	10	mA	
Collector dissipation	max.	850	kW	note 10
Dissipation body circuit I	max.	10	kW	
Dissipation body circuit II	max.	15	kW	
C.W. output power	max.	630	kW	
Load VSWR	max.	1.2		note 11
Temperature rise, window cooling air flow	max.	30	K	

TYPICAL OPERATING CONDITIONS

500 kW operation into matched load	min.	typ.	max.		
Cathode voltage to body (ground)	−60	−62	−63	kV	
Cathode current	4	14	15	A	note 12
Input power, d.c.	–	867	–	kW	
Accelerator anode voltage to cathode	0	43	–	kV	note 12
Accelerator anode current	–	1	5	mA	
C.W. output power, VSWR ⩽ 1.1	500	520	–	kW	
Collector dissipation	–	347	850	kW	note 10
Efficiency	58	60	–	%	
C.W. drive power	–	25	50	W	

600 kW operation into matched load					
Cathode voltage to body (ground)	−62	−64	−65	kV	
Cathode current	4	15.9	16.5	A	note 12
Input power, d.c.	–	1017	–	kW	
Accelerator anode voltage to cathode	0	47	–	kV	note 12
Accelerator anode current	–	1	5	mA	
C.W. output power, VSWR ⩽ 1.1	600	610	–	kW	
Collector dissipation	–	407	850	kW	note 10
Efficiency	57	60	–	%	
C.W. drive power	–	25	50	W	

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 10% above specified values			
Cathode voltage to body (ground)	max.	−77	kV	
Cold cathode voltage to body (ground)	max.	−85	kV	
Cathode current	max.	18	A	
Accelerator anode voltage to cathode	max.	65	kV	note 9
Cold accelerator anode voltage to cathode	max.	75	kV	
Accelerator anode current	max.	10	mA	
Collector dissipation	max.	850	kW	note 10
Dissipation body circuit I	max.	10	kW	
Dissipation body circuit II	max.	15	kW	
C.W. output power	max.	820	kW	
Load VSWR	max.	1.2		note 11
Temperature rise, window cooling air flow	max.	30	K	

TYPICAL OPERATING CONDITIONS

800 kW operation into matched load	min.	typ.	max.		
Cathode voltage to body (ground)	−75	−76	−77	kV	
Cathode current	4	17	18	A	note 12
Input power, d.c.	–	1300	–	kW	
Accelerator anode voltage to cathode	0	47	50	kV	note 12
Accelerator anode current	–	2	5	mA	
C.W. output power, VSWR $\leqslant$ 1.1	750	800	820	kW	
Collector dissipation	–	500	850	kW	note 10
Efficiency	60	61	–	%	
C.W. drive power	–	40	70	W	

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 10% above specified values			
Cathode voltage to body (ground)	max.	−50	kV	
Cold cathode voltage to body (ground)	max.	−55	kV	
Cathode current	max.	15	A	
Accelerator anode voltage to cathode	max.	45	kV	note 9
Cold accelerator anode voltage to cathode	max.	50	kV	
Accelerator anode current	max.	10	mA	
Collector dissipation	max.	400	kW	note 10
Dissipation body circuit I	max.	6	kW	
Dissipation body circuit II	max.	10	kW	
C.W. output power	max.	370	kW	
Load VSWR	max.	1.2		note 12
Temperature rise, window cooling air flow	max.	30	K	

TYPICAL OPERATING CONDITIONS

350 kW operation into matched load	min.	typ.	max.		
Cathode voltage to body (ground)	−47	−48	−49	kV	
Cathode current	4	12	13	A	note 13
Input power, d.c.	–	580	600	kW	
Accelerator anode voltage to cathode	0	36.5	–	kV	note 13
Accelerator anode current	–	1	5	mA	
C.W. output power, VSWR $\leqslant$1.1	315	330	370	kW	
Collector dissipation	–	230	400	kW	note 10
Efficiency	55	58	–	%	
C.W. drive power	–	16	30	W	

PERFORMANCE DATA

Phase shift to cathode current	$<$	20	^{o}/A
Phase shift to rel. cathode voltage	$<$	20	^{o}/%
Phase shift to r.f. drive	$<$	12	^{o}/dB
R.F. output to rel. cathode voltage	$<$	0.3	dB/%
Spurious noise amplitude			
for f $<$ 300 Hz	$\leqslant$	3	%
for f = 300 to 1000 Hz	$\leqslant$	1	%
for f $>$ 1000 Hz	$\leqslant$	0.5	%

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. Required values are given with each tube.
3. For further recommendations please contact the tube manufacturer.
4. Separately shipped together with each tube and to be returned together with each burnt-out tube.
5. It is recommended to return the coaxial/waveguide transition together with burnt-out tube for inspection.
6. R3 sockets are only usable together with optional accessories TE1159 and TE1160.
7. Cable with R3 plugs on each end, to be fed into the R3 sockets of the H.V. connection unit TE1163 and into R3 sockets TE1158 applied to the power supply. Dummy plugs are provided for cable termination on H.V. test of the cable set.
8. Parts are needed for all handling operations at the site and are to be ordered once for the site.
9. The accelerator anode voltage may never become positive with respect to the body (ground).
10. It must be observed that for operation with reduced r.f. drive the maximum value for collector dissipation is not exceeded.
11. For reflections exceeding this value please contact the tube manufacturer.
12. The klystron should not be operated with a cathode current below 4 A except for switching purposes.

INSTALLATION AND OPERATION REQUIREMENTS

A. Required interlocks

1. Fast switch-off of the drive power within 10 ms has to be done if the arc detector and/or r.f. reflection indicator is activated. An arc detector must be provided at the knee of the output waveguide.

2. A fast switch-off of the beam supply has to be provided when one of the following situations occurs:
   a) the beam current increases rapidly,
   b) the solenoid current deviates by more than ± 5% from the adjusted value.

   The switching sensors and the discharge facilities for the power supply must be designed so that a copper wire of 0.35 mm diameter, connected to the power supply instead of the klystron (length approx. 1 cm/kV), will not be destroyed, if the full operating voltage is switched on and applied to the wire.

3. The mains for the beam power supply has to be switched off within 100 ms when one of the following situations occur:
   a) the beam current either exceeds the limiting value or increases by more than 30% or max. 2 A above the adjusted value,
   b) the pump current exceeds 10 μA,
   c) the monitored temperature differences between inlet and outlet in the collector and/or body cooling circuits are too high;

max. values permitted:	collector	$\Delta\theta$ = 15 K
	body circuit I	$\Delta\theta$ = 15 K
	body circuit II	$\Delta\theta$ = 15 K

   d) the water flow of the collector and body cooling circuits decreases below the required minimum value,
   e) the air flow for the r.f. window and cathode cooling decreases below the required minimum value.

4. Switch-off the heater voltage for pump current > 4 mA.

Restarting is not allowed within 10 s of any interruption.

B. Switching-on and off sequence

Switching-on sequence

1. Cathode cooling on.
2. Getter-ion pump supply on.
3. Check that the pump current is < 10 μA.
4. Heater voltage supply on.
5. Wait for preheating time (min. 15 minutes).
6. Cooling air r.f. window on.
7. Cooling body circuits I and II on.
8. Collector cooling supply on.
9. Solenoid current supply on.
10. Check that the heater current has reached the adjusted value ± 0.5 A.
11. R.F. drive on.
12. Beam supply on.

Switching-off sequence

1. Beam voltage supply off.
2. All other supplies and cooling circuits off.

C. Radiation dangers

RF radiation

RF power may be emitted not only through the normal output coupling but also through other apertures (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.

X-radiation

Due to the high accelerating voltage, the klystron generates a high level of X-rays. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
The tube manufacturer recommends a shielding made from lead sheets at least 3 mm thick and capable of reducing the X-radiation to a safe level.
The compliance with the local regulations regarding radiation hazards has to be confirmed by the user. If in any doubt refer to your local PHILIPS representative or the manufacturer.
Care must be taken in the construction of this shielding to avoid any holes or slots.

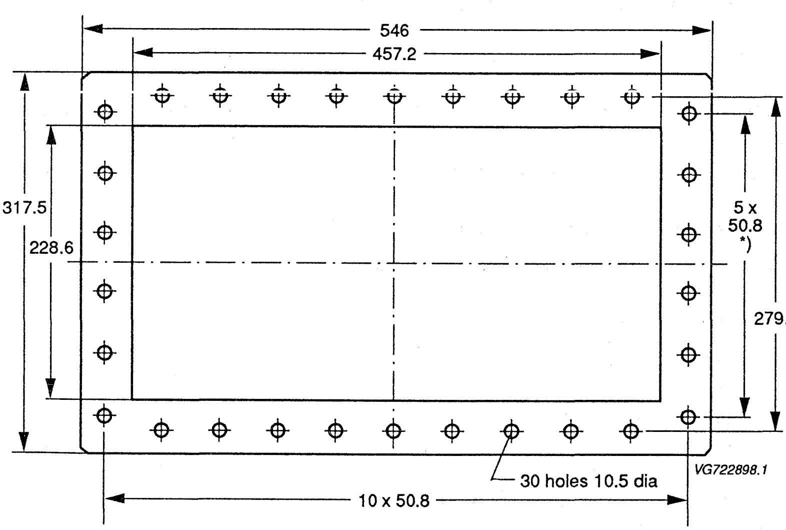


Fig. 4 Flange CPR 1800 (non standard *))

CONTINUOUS-WAVE HIGH-POWER KLYSTRON

Vapour cooled, high efficiency, fixed frequency, continuous-wave high-power klystrons in metal-ceramic construction, for use in scientific and industrial applications. The tubes have internal cavities, solenoid focusing, beam control by accelerator anode and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	508.6	MHz
Bandwidth at saturation (−1 dB points)	2	MHz
Output power	800	kW
Cooling	vapour	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by a.c. or d.c.

		min.	typ.	max.		notes
Cathode	dispenser type					
Heater voltage	V_f	22	25	27	V	
Heater current	I_f	20	23	25	A	1, 2
Cold heater resistance	R_{fo}	–	100	–	mΩ	
Waiting time	t_w	15	–	–	minutes	

FOCUSING: electromagnetic

	min.	typ.	max.		notes
Main focusing section					
Solenoid current	–	7	8	A	2, 3
Solenoid voltage	–	500	600	V	
Solenoid resistance	–	80	–	Ω	
Prefocusing coil					
Solenoid current	–	5	7	A	2, 3
Solenoid voltage	–	30	40	V	
Solenoid resistance	–	6	–	Ω	

ION-GETTER PUMP SUPPLY

	min.	typ.	max.	
Operating voltage	3	3.3	4	kV
Operating current	–	$\approx 10^{-3}$	80	mA
Internal resistance of power supply	25	300	–	kΩ

MECHANICAL DATA

Dimensions in mm

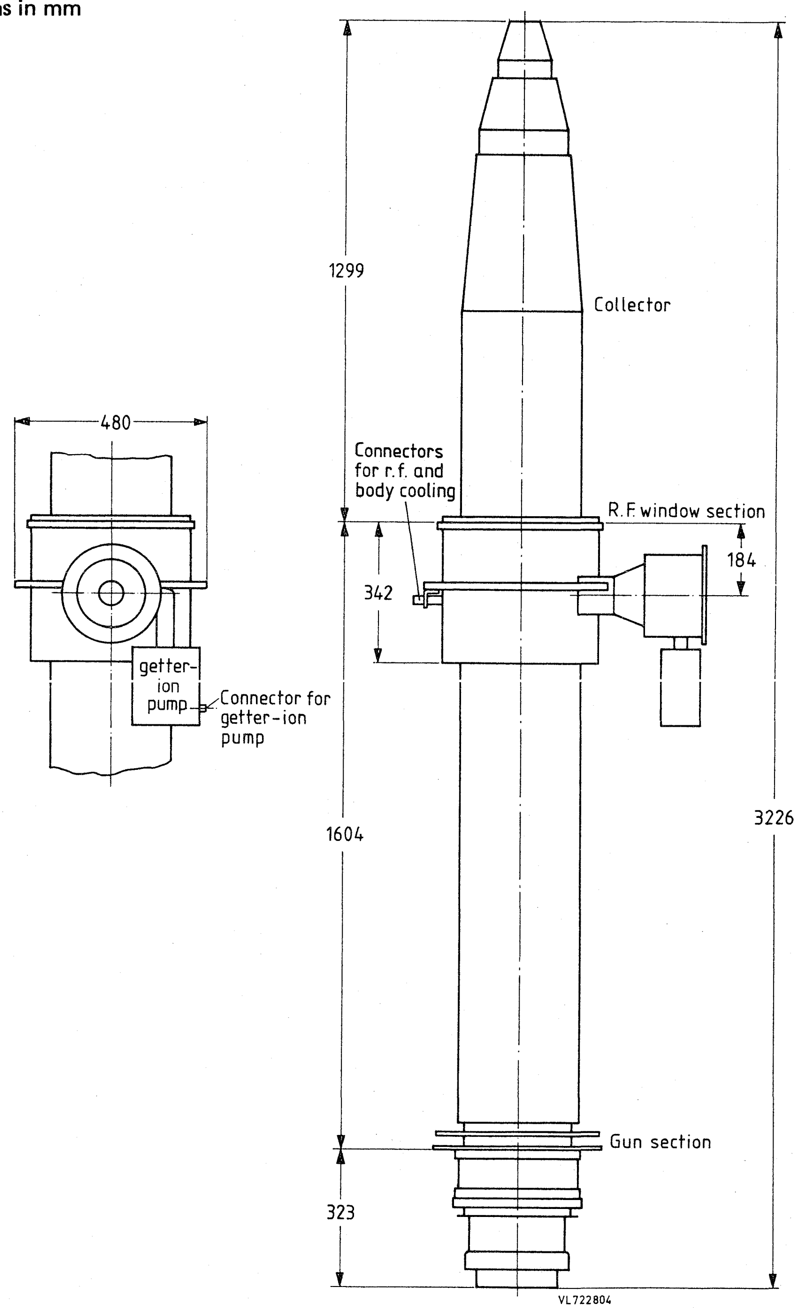


Fig. 1.

Tube mounted in the mounting frame with solenoid.

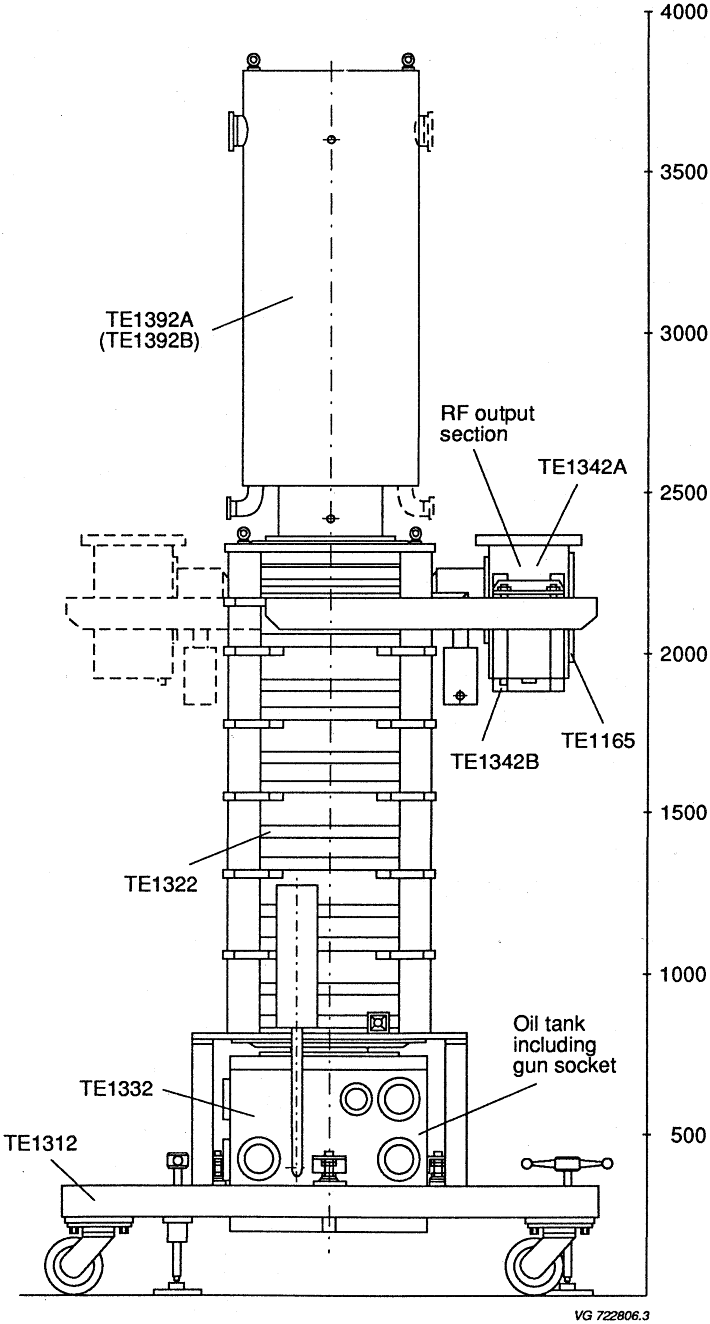


Fig. 2.
Drawing shows klystron and trolley without operational lead-shielding.

COOLING	min.	typ.	max.		
Vapour cooling of collector					
demineralized or distilled water	50	100	–	ℓ/min	note 4, 5
pressure drop at 100 ℓ/min	–	–	20	kPa	(= 200 mbar)
Water cooling of body circuit I					
demineralized or distilled water with 10% stabilized glycol added	10	14	–	ℓ/min	note 5
pressure drop	–	300	–	kPa	(= 3 bar)
Water cooling of body circuit II					
demineralized or distilled water with 10% stabilized glycol added	15	20	–	ℓ/min	note 5
pressure drop	–	300	–	kPa	(= 3 bar)
Output window					
air	0.6	1.2	–	m^3/min	
pressure drop	–	9	–	kPa	(= 90 mbar)
Inlet water temperature	–	–	+50	°C	
Inlet air temperature	–	–	+45	°C	

Cathode socket and accelerator anode under oil

MASS

Net mass YK1302	500 kg
Mounting frame with solenoid	1400 kg
Boiler	150 kg
Capability of hoist	min. 600 kg

DIMENSIONS

Tube and mounting frame	see drawings
Required ground clearance for lifting hoist	min. 650 cm

MOUNTING vertical, collector up

R.F. CONNECTORS

Input	N-type, female
Output	waveguide R5 (WR1800) mating flange CPR1800 (non-standard, see Fig. 3)

ACCESSORIES

Klystron trolley with waveguide support	TE1312B
Focusing coil unit	TE1322
Oil tank (DC heating version)	TE1332 *
Coax/waveguide transition, WR 1800	TE1342A
Support for TE1342A	TE1342B
Lead shielding	TE1362
Trolley for transportation of a klystron in horizontal position without lifting gear	TE1372A
Lifting appliance for TE1312B	TE1312Z
Supporting frame for storage and any movement of burnt-out or spare klystrons in any position other than vertical	TE1372B
Lifting yoke	TE1382
Boiler	TE1392A
Steam duct	TE1392B

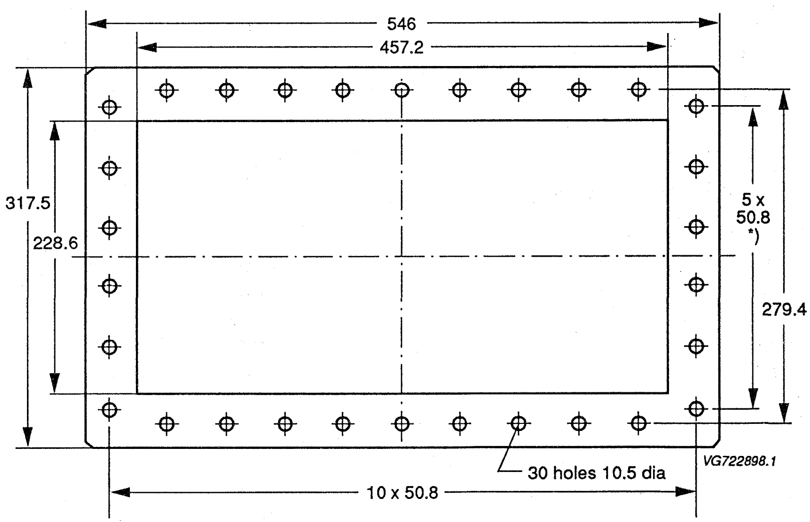


Fig. 3 Flange CPR 1800 (non standard *))

* high voltage connectors excluded; to be defined by user

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 10% above specified values			
Cathode voltage to body (ground)	max.	−85	kV	
Cold cathode voltage to body (ground)	max.	−90	kV	
Cathode current	max.	20	A	
Accelerator anode voltage to cathode	max.	65	kV	note 6
Accelerator anode current	max.	5	mA	
Collector dissipation				note 7
output power > 200 kW	max.	750	kW	
output power < 200 kW	max.	500	kW	
Dissipation body circuit I	max.	15	kW	
Dissipation body circuit II	max.	10	kW	
C.W. output power	max.	850	kW	
Load VSWR	max.	1.2		note 8
Temperature rise, window cooling air flow	max.	30	K	

TYPICAL OPERATING CONDITIONS

800 kW operation into matched load	min.	typ.	max.		
Cathode voltage to body (ground)	−76	−80	–	kV	
Cathode current	–	16.5	–	A	note 9
Input power, d.c.	–	1322	–	kW	
Accelerator anode voltage to cathode	–	52	–	kV	note 9
Accelerator anode current	–	1.5	–	mA	
C.W. output power, VSWR ⩽1.1	–	800	–	kW	
Collector dissipation	–	522	–	kW	note 7
Efficiency	60	60.5	–	%	
C.W. drive power	–	60	80	W	

PERFORMANCE DATA

Harmonic content with respect to fundamental			
2nd order	max.	−25	dB
3rd order	max.	−25	dB
Spurious noise amplitude			
for f < 300 Hz	⩽	1	%
for f = 300 to 1000 Hz	⩽	1	%
for f > 1000 Hz	⩽	0.5	%

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 65 A.
2. Required values are given with each tube.
3. Further adjustment according to operating instructions.
4. Volume of water converted to steam: 27 cm^3/min per kW collector dissipation in 43 ℓ/min steam per kW collector dissipation.
5. For further recommendations please contact the tube manufacturer.
6. The accelerator anode voltage may never become positive with respect to the body (ground).
7. It must be observed that for operation with reduced r.f. drive the maximum value for collector dissipation is not exceeded.
8. For reflections exceeding this value please contact the tube manufacturer.
9. The klystron should not be operated with a cathode current below 4 A except for switching purposes.

INSTALLATION AND OPERATION REQUIREMENTS

A. Required interlocks

1. Fast switch-off of the drive power within 30 ms has to be done if the arc detector and/or r.f. reflection indicator is activated. An arc detector must be provided at the knee of the output wave guide.
2. A fast switch-off of the beam supply has to be provided when one of the following situations occurs:
   a) the beam current increases rapidly,
   b) the solenoid current deviates by more than ± 5% from the adjusted value.
   The switching sensors and the discharge facilities for the power supply must be designed so that a copper wire of 0.35 mm diameter, connected to the power supply instead of the klystron (length approx. 1 cm/kV), will not be destroyed, if the full operating voltage is switched on and applied to the wire.
3. The mains for the beam power supply has to be switched off within 100 ms when one of the following situations occur:
   a) the collector temperature monitor (with internal thermocouple) is activated (T = max. 150 °C),
   b) the monitored temperature differences between inlet and outlet in the collector and/or body cooling circuits are too high:

max. values permitted:	body circuit I	$\Delta\theta$ = 15 K
	body circuit II	$\Delta\theta$ = 15 K

   c) the beam current either exceeds the limiting value or increases by more than 30% or max. 2 A above the adjusted value,
   d) the water flow of the body cooling circuits decreases below the required minimum value,
   e) the air flow for the r.f. window cooling decreases below the required minimum value,
   f) the thermocouple temperature at the inner conductor of the output window exceeds 90 °C,
   g) the pump current exceeds 10 μA.

Restarting is not allowed within 10 s of any interruption.

B. Switching-on and off sequence

Switching-on sequence

1. Getter-ion pump supply on.
2. Check that the pump current is < 10 μA.
3. Heater voltage supply on.
4. Wait for preheating time (min. 15 minutes).
5. Cooling air r.f. window on.
6. Cooling body circuits I and II on.
7. Collector cooling supply on.
8. Solenoid current supply on.
9. Check that the heater current has reached the adjusted value ±0.5 A.
10. R.F. drive on.
11. Beam supply on.

Switching-off sequence

1. Beam voltage supply off.
2. All other supplies and cooling circuits off.

C. Radiation dangers

RF radiation

RF power may be emitted not only through the normal output coupling but also through other apertures (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.

X-radiation

Due to the high accelerating voltage, the klystron generates a high level of X-rays. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
The tube manufacturer recommends a shielding made from lead sheets at least 3 mm thick and capable of reducing the X-radiation to a safe level.
The compliance with the local regulations regarding radiation hazards has to be confirmed by the user. If in any doubt refer to your local PHILIPS representative or the manufacturer.
Care must be taken in the construction of this shielding to avoid any holes or slots.

CONTINUOUS WAVE HIGH-POWER KLYSTRON

Vapour cooled, high efficiency, fixed frequency, continuous wave high-power klystron in metal-ceramic construction, for use in scientific and industrial applications. The tube has internal cavities, solenoid focusing, 100 % beam control by accelerator anode and a high stability dispenser-type cathode. Collector at ground potential, electron gun oil-insulated.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	508.6	MHz
Bandwidth at saturation (−1 dB points)	1	MHz
Output power	1	MW
Collector cooling	vapour	
Body cooling	water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by AC or DC*						notes
Cathode	dispenser type					
		min.	typ.	max.		
Heater voltage	V_f	22	25	27	V	
Heater current	I_f	20	23	24	A	1, 2
Cold heater resistance	R_{fo}	–	100	–	mΩ	
Preheating time	t_w	15	–	–	minutes	
FOCUSING: electromagnetic						
Main focusing section						
Solenoid current		8	9	10	A	2, 3
Solenoid voltage		–	700	850	V	
Solenoid resistance		–	80	–	Ω	
Prefocusing coil (counter coil)						
Solenoid current		0	1	3	A	2, 3
Solenoid voltage		–	6	20	V	
Solenoid resistance		–	6	–	Ω	
ION-GETTER PUMP SUPPLY						
Operating voltage		3	3.3	4	kV	
Operating current		–	$\approx 10^{-3}$	10	mA	
Internal resistance of power supply		–	300	–	kΩ	

* for AC special high voltage tank is required

MECHANICAL DATA

Dimensions in mm

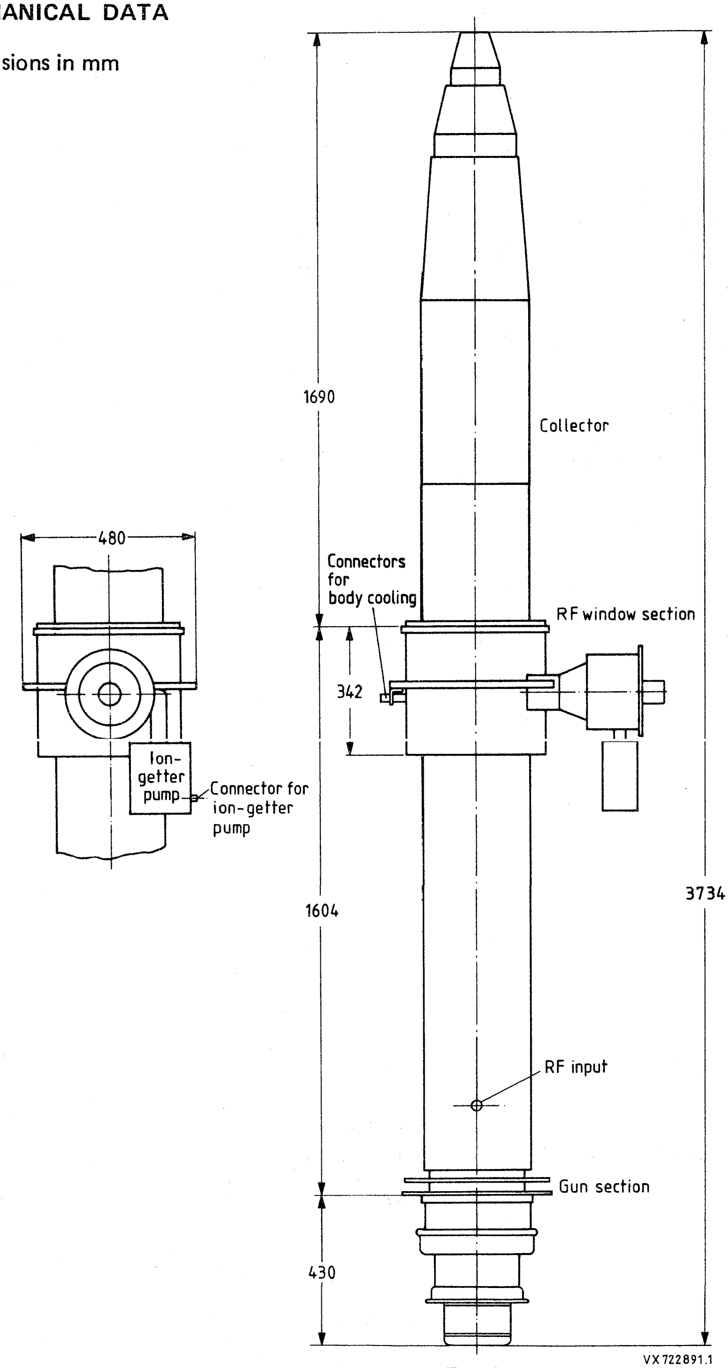


Fig. 1.

COOLING	min.	typ.	max.			
Collector						
Vapour cooling						
Cooling water flow rate	60	100	–	ℓ/min		note 4
Inlet water temperature	–	–	90	°C		note 5
Pressure drop (at 60 ℓ/min)	–	–	20	kPa	(= 0.2 bar)	
Body circuit I						
Water cooling by demineralized water						
Cooling water flow rate	15	–	–	ℓ/min		
Inlet water temperature	–	–	+45	°C		note 5
Outlet water temperature	–	–	+60	°C		
Difference between inlet and outlet temperature (at 15 ℓ/min)	–	–	15	K	see Fig. 4	
Static pressure	–	–	800	kPa	(= 8 bar),	note 12
Pressure drop (at 15 ℓ/min)	–	–	550	kPa	(= 5.5 bar)	
Body circuit II						
Water cooling by demineralized water						
Cooling water flow rate	25	–	–	ℓ/min		
Inlet water temperature	–	–	+45	°C		note 5
Outlet water temperature	–	–	+60	°C		
Difference between inlet and outlet temperature (at 25 ℓ/min)	–	–	6	K	see Fig. 4	
Static pressure	–	–	800	kPa	(= 8 bar),	note 12
Pressure drop (at 25 ℓ/min)	–	–	150	kPa	(= 1.5 bar)	
RF window						
Dry and filtered air						
Flow rate	1.6	–	–	m^3/min		note 9
Pressure drop (at 1.6 m^3/min)	–	–	10	kPa	(= 0.1 bar)	
Inlet temperature	5	–	45	°C		

Cathode and modulating anode sockets under oil

MASS

Net mass YK1303		570	kg
Mounting frame with solenoid		900	kg
Lead shield		540	kg
Boiler		80	kg
Capability of hoist	min.	650	kg

DIMENSIONS

Tube and mounting frame	see drawings		
Required ground clearance for lifting hoist	min.	650	cm

MOUNTING

vertical, collector up

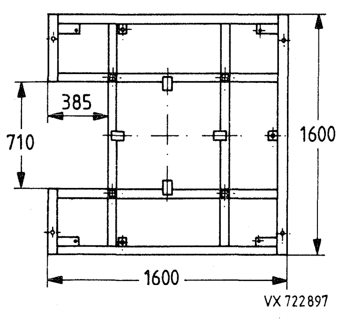
RF CONNECTORS

Input	N-type, female
Output	waveguide R5 (WR 1800) flange CPR 1800 (non-standard, see Fig. 3)

MECHANICAL DATA

Dimensions in mm

Set-up can be assembled with high voltage connectors pointing to the rear side, also.



VIEW X

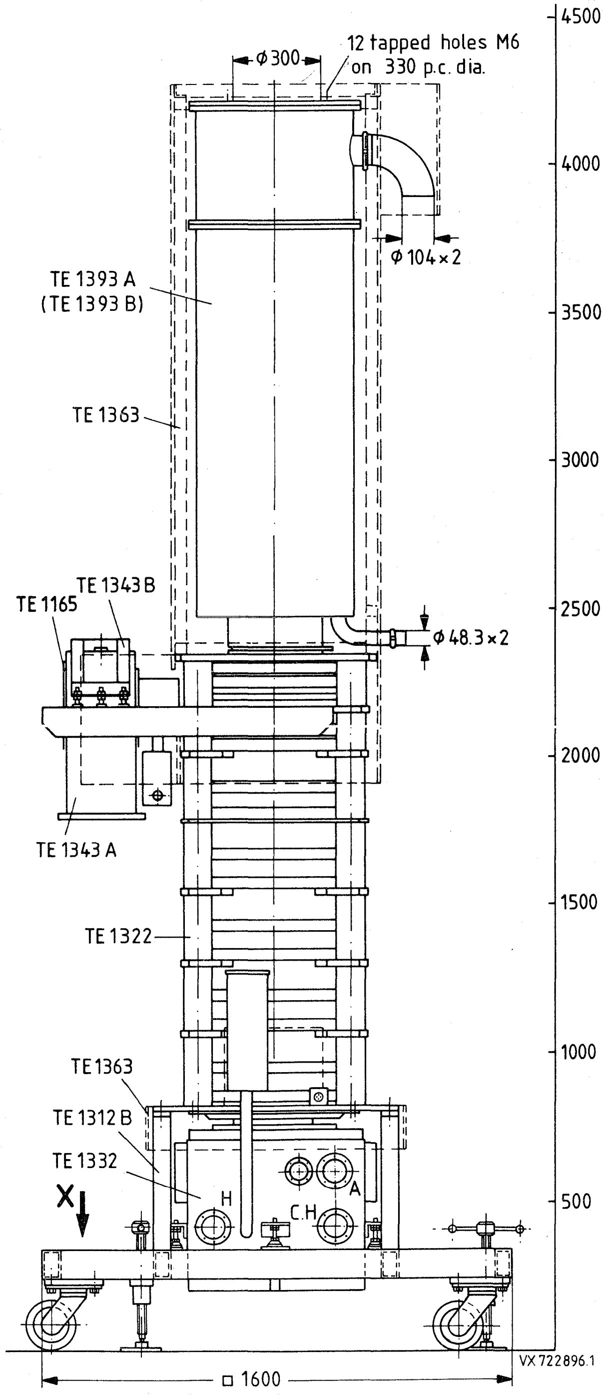


Fig. 2.

ACCESSORIES

Operational equipment

Air inlet for RF window cooling	TE1165	
Klystron trolley	TE1312B	
Focusing coil unit	TE1322	
Oil tank (DC heating version)	TE1332 *	
Coax/waveguide transition, WR1800	TE1343A	
Support for TE1343A	TE1343B	
Lead shielding	TE1363	
Boiler	TE1393A	
Steam duct	TE1393B	

Transportation and handling equipment

Lifting appliance for TE1312B	TE1312Z	recommended (1 per site)
Klystron support frame for transport	TE1372B	
Klystron transport trolley	TE1373A	
Lifting collar	TE1373B	
Lifting yoke and cantilever	TE1383	(1 per site)

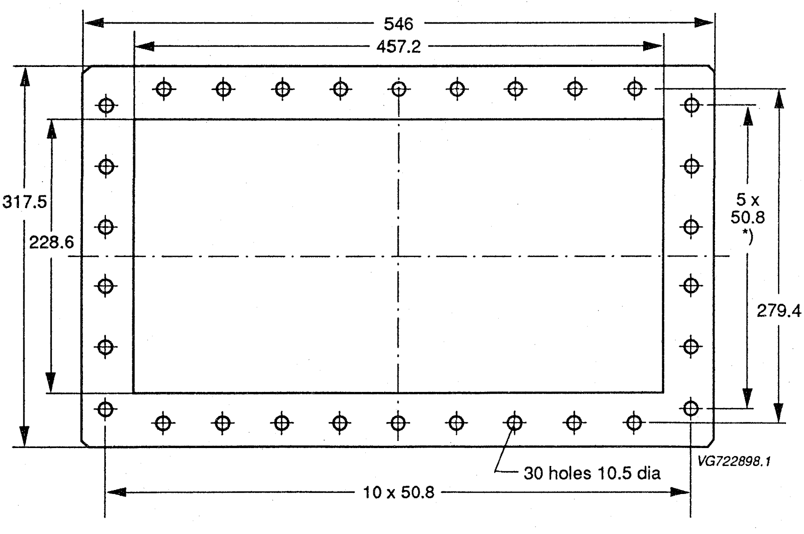


Fig. 3 Flange CPR 1800 (non standard *))

* high voltage connectors excluded; to be defined by user

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	27 V	
Heater current	max.	24 A	note 1
Cathode to body (ground) voltage	max.	− 95 kV	
Cold cathode to body (ground) voltage	max.	−110 kV	
Cathode current	max.	22 A	
Modulating anode to cathode voltage	max.	65 kV	note 6
Modulating anode current	max.	+5/−1.4 mA	
Collector dissipation	max.	900 kW	note 10
Dissipation body circuit I	max.	15 kW	
Dissipation body circuit II	max.	10 kW	
CW output power	max.	1050 kW	note 7
Load VSWR	max.	1.2	note 8
Temperature rise, window cooling air flow	max.	40 K	note 9
Collector temperature			note 11
probe 1	max.	160 °C	
probe 2	max.	140 °C	
Oil tank temperature	max.	80 °C	

TYPICAL OPERATING CONDITIONS

1000 kW operation into matched load
(VSWR ⩽ 1.05)

	min.	typ.	max.		
Cathode to body (ground) voltage	–	–90	–	kV	note 2
Cathode current	–	18.2	–	A	
Input power DC	–	1638	–	kW	
Modulating anode to cathode voltage	50	56	65	kV	
Modulating anode current	–	+ 1.5	+2.5/-1.4	mA	
CW output power	–	1000	–	kW	
Collector dissipation	–	625	–	kW	
Efficiency	60	61	–	%	
CW drive power	–	80	100	W	
Ion-getter pump current	–	0.5	2	μA	
Collector temperature (contact probes)	–	105	–	°C	note 11
Body dissipation					
circuit 1	–	8	15	kW	
circuit 2	–	5	10	kW	

PERFORMANCE DATA

Harmonic content suppression with respect to fundamental	min.	25	dB	*
Spurious noise amplitude				
for f < 300 Hz	⩽	3	%	
for f = 300 to 1000 Hz	⩽	1	%	
for f > 1000 Hz	⩽	0.5	%	

* matched load at harmonic frequencies provided

Notes

1. When switching on the heater voltage, the heater current must never exceed a peak value of 30 A.
2. Required operational values (name plate values) are given with each tube.

   Adjustment tolerances
   - Heater current
     Name plate value +0.5 A/−1 A; for recommended heater power reduction during life consult manual.
   - Main section solenoid current
     Name plate value + 0.4 A/−0.2 A to prevent thermal drift, a long term stabilisation of the solenoid currents of 10^{-2} is required.
   - Pre focusing solenoid current
     Name plate value ± 0.1 A.
   - Cathode to body (ground) voltage
     Name plate value + 1kV/−2 kV.
3. Further adjustment according to operating instructions.
4. Demineralized or destilled water must be used.

   Volume of water converted to steam: 27 cm^3/min per kW collector dissipation in 43 ℓ/min steam per kW collector dissipation.
   For further recommendations please contact the tube manufacturer.
5. Minimum inlet water temperature 2 K above ambient temperature.
6. The accelerator anode voltage must never become positive with respect to the body (ground).
7. For test purposes (window test etc.) max. 1100 kW for 1 h.
8. For operating conditions at reflections exceeding this value please contact the tube manufacturer.
9. Cooling air must be dried and filtered. For further recommendations please contact tube manufacturer. For 1100 kW test operation a minimum air flow of 1.8 m^3/min is required.
   The temperature rise of the window cooling air is measured by means of two thermocoupler at air inlet and outlet. One Ni-CrNi thermocouple is factory assembled at the air outlet.
10. The maximum collector dissipation can be reached under the following operating conditions:
    a) Reducing the RF drive power at the nominal 1 MW operating condition (klystron beam current = const.).
    b) Reducing the beam current from the nominal 1 MW operating condition (RF drive power = const.).
    c) Raising the klystron beam power without RF drive.
11. Two Ni-CrNi thermo couples are attached to the collector top probing a temperature inside the collector wall.
12. Maximum permissible value for pressure shocks (transients): 1000 kPa (10 bar).

INSTALLATION AND OPERATION REQUIREMENTS

A. Safety Interlocks

1. Overcurrent and overvoltage (crowbar) protection of the klystron.
   In order to protect the klystron from damage under fault conditions, the customer must supply overcurrent and overvoltage protection.
   Under no circumstances must the energy supplied to the tube exceed 40 joule (or the area under the beam current/time curve ($\int I^2\, dt$) exceed 40 $A^2 s$).
   Specific crowbar circuit design is the customer's responsibility. However the following test should be applied:
   If the klystron is replaced by a copper wire of 0.35 mm diameter (length 1 cm/kV), this copper wire must not be destroyed if the full beam voltage is applied.
   The crowbar circuit must be designed to divert any overcurrent from the tube within 100 μs under either of the following conditions:
   - if the beam current increases at a rate greater than 10 A/μs
   - if the focusing current deviates more than 0.1 A from the adjustment tolerance range as given in note 2.

2. The customer must supply protection circuitry to switch off the beam voltage within 100 ms under any of the following conditions:
   - if the beam current exceeds 22 A or if it increases by more than 2 A above the set value
   - if the ion-getter pump current exceeds 10 μA
   - if the monitored temperatures or temperature differences of the body or collector cooling circuits exceed the limiting values
   - if the collector temperature measured by the thermocouples exceeds the given limiting values
   - if the flow rate of the collector cooling water falls below 60 litres per minute
   - if the flow rate of the body cooling water falls below the limiting values
   - if the air flow rate at the output window falls below 1.6 m^3 per minute
   - if the window temperature difference exceeds 40 K.

3. The customer must supply protection circuitry to disconnect the RF drive within 10 μs under either of the following conditions:
   - if the arc sensor is activated
   - if the RF reflection indicator shows a fault condition in the waveguide (VSWR $>$ 1.3)
   - Collector dissipation must not exceed 900 kW for more than 100 ms. Necessary reduction of beam power after drive disconnection has to be achieved within 100 ms.

4. Protection of the filament
   In order to protect the filament from damage under fault conditions, the customer must provide a protection circuit which will switch off the filament supply within 1 second if the ion-getter pump current exceeds 4 mA.

5. Restarting
   Restarting after any of the above interlock actions must not take place until at least 10 s have elapsed. Under certain conditions this restart time could be reduced with the permission of the klystron manufacturer.

B. Switching-on and off sequence

Switching-on sequence

It is important that the klystron supplies are switched on in the following sequence, unless otherwise agreed with the klystron manufacturer:

1. Ion-getter pump supplies on.
2. Wait until the value of the pump current falls below $< 10\ \mu A$.
3. Filament supply on.
4. Connect output window air supply.
5. Connect both body cooling water supplies.
6. Connect collector cooling water supply.
7. Connect focusing solenoid main-field supply.
8. Connect the RF drive input.
9. Check that the filament and solenoid current are within ±1 % of the value given in the acceptance document or manual.
10. Allow at least 15 minutes warm-up period until entering step 11.
11. Connect the high voltage cathode (beam) supply and mod. anode supply simultaneously.

Steps 4 through 8 may be performed simultaneously.

Switching-off sequence

1. Switch-off mod. anode high voltage supply.
2. Switch-off the cathode high voltage supply.
3. Switch-off all other supplies and cooling circuits.

C. Radiation dangers

RF radiation

RF power may be emitted through uncorrectly fitted flanges or defective parts of the output feeder. This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.
Under correct operating conditions the RF radiation 1 m apart from any part of the klystron at 1 MW output power will not exceed 0.1 mW/cm^2.

X-radiation

Due to the high accelerating voltage, the klystron generates a high intensity X-radiation. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
Tube and accessories are equipped with a lead shield which reduces the radiation values below 1 mR/h, measured at a distance of 1 m from the tube, correct assembly provided.

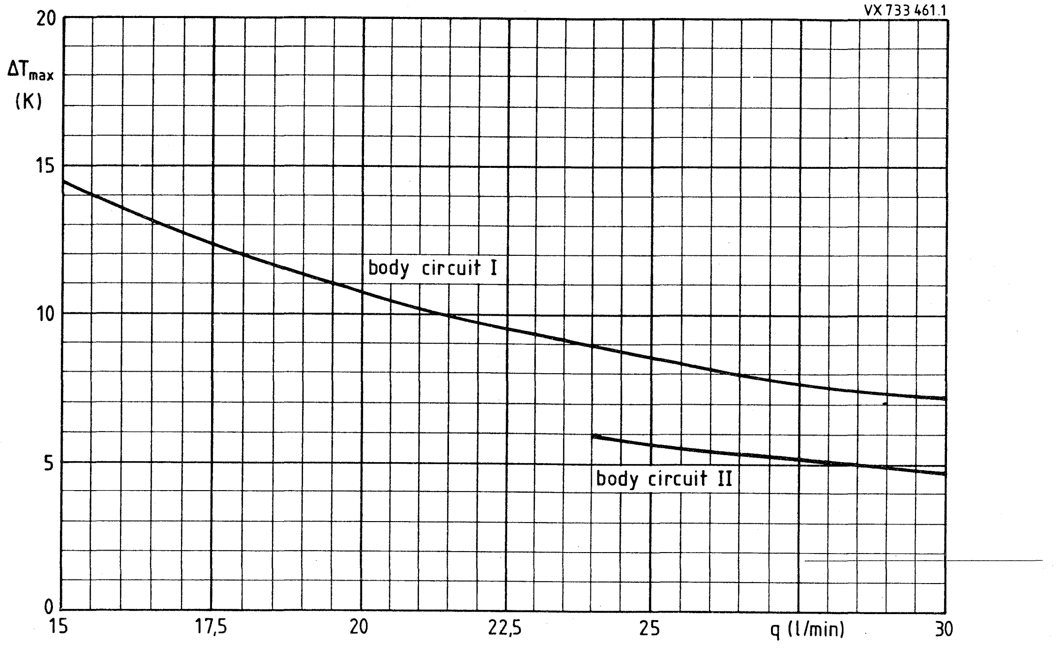


Fig. 4 Maximum difference between inlet and outlet temperature versus water flow rate in body circuit I and II.

CONTINUOUS WAVE HIGH-POWER KLYSTRON

Water cooled, high efficiency, fixed frequency, continuous-wave high-power klystron in metal-ceramic construction, for use in scientific and industrial applications. The tube has internal cavities, solenoid focusing, beam control by modulation anode and a high stability dispenser-type cathode.

QUICK REFERENCE DATA

Centre frequency (fixed tuned)	352.21	MHz
Bandwidth for 1dB drop in output power	± 0.5	MHz
Output power	1	MW
Cooling	water	

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by AC or DC

Cathode — dispenser type

		min.	typ.	max.	
Heater voltage	V_f	22	25	29	V
Heater current	I_f	20	23	25	A
Cold heater resistance	R_{fo}	–	100	–	mΩ
Preheating time	t_w	15	–	–	minutes
FOCUSING: electromagnetic					
Solenoid current		8	10	12	A
Solenoid voltage		–	200	250	V
Solenoid resistance		–	20	–	Ω
ION-GETTER PUMP SUPPLY *					
Operating voltage		3	3.3	4	kV
Operating current		–	10^{-3}	10	mA
Internal resistance of power supply		–	300	–	kΩ

* The tube is equipped with two Ion getter pumps which can be operated individually or in a parallel arrangement at one power supply.

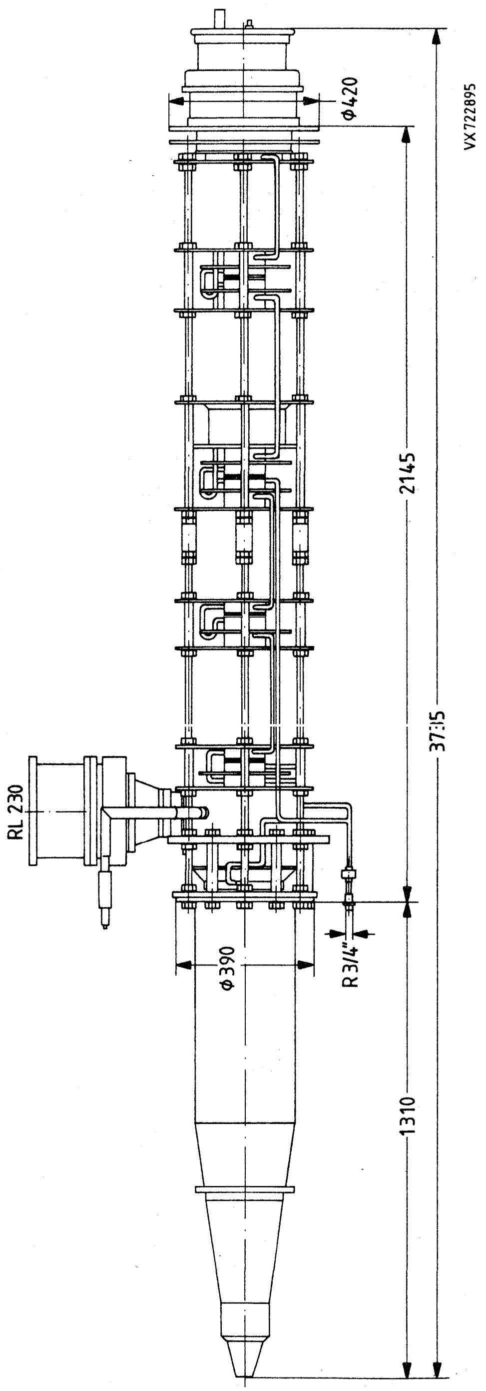


Fig. 1.

MECHANICAL DATA

Dimensions in mm

COOLING	min.	typ.	max.		
Cooling of collector and body sections is achieved by filtered soft water.					
Pressure in any cooling water circuit	–	–	700	kPa	(= 7 bar)
Pressure drop	–	–	300	kPa	(= 3 bar)
Collector					
cooling water flow rate	800	1000	1200	l/min	
inlet water temperature	–	+20	+75	°C	
outlet water temperature	–	+30	+90	°C	
difference between inlet and outlet temperature (at 800 l/min) *	–	–	16	K	see Fig. 3
Body circuit I					
cooling water flow rate	10	15	20	l/min	
inlet water temperature	–	+20	+45	°C	
outlet water temperature	–	+25	+60	°C	
difference between inlet and outlet temperature (at 15 l/min) *	–	–	10	K	see Fig. 4
Body circuit II					
cooling water flow rate	10	15	20	l/min	
inlet water temperature	–	+20	+45	°C	
outlet water temperature	–	+25	+60	°C	
difference between inlet and outlet temperature (at 15 l/min) *	–	–	10	K	see Fig. 4
Output window					
air	–	1	–	m^3/min	
pressure drop	–	5	–	kPa	(= 50 mbar)

MASS

Mass of complete assembly without demountable X-ray shield	max. 2000 kg

DIMENSIONS of complete assembly

Length	approx. 4 m
Heigh	approx. 1.9 m
Width	approx. 1 m

MOUNTING horizontal

COOLING WATER CONNECTORS

Body circuits I and II	conical 1 inch Whitworth pipe thread DIN 2999
Collector	Sandvik FCL-316L-76, 1-S-V

RF CONNECTORS

Input	female connector, 50 Ω, type N
Output	WR2300 waveguide
Output cavity monitor (optional)	female connector, 50 Ω, type N

* at higher flow rates this value must be reduced accordingly

ACCESSORIES

Transportation and operation frame with coils	TE1351
Coaxial/waveguide transition, WR2300 (R3)	TE1352
Waveguide support	TE1353
Collector cooling jacket I	TE1354A
Collector cooling jacket II	TE1354B
Cooling water manifold	TE1355A
Interconnecting hoses	2 x TE1355B
HV oil tank without HV connections *	TE1356

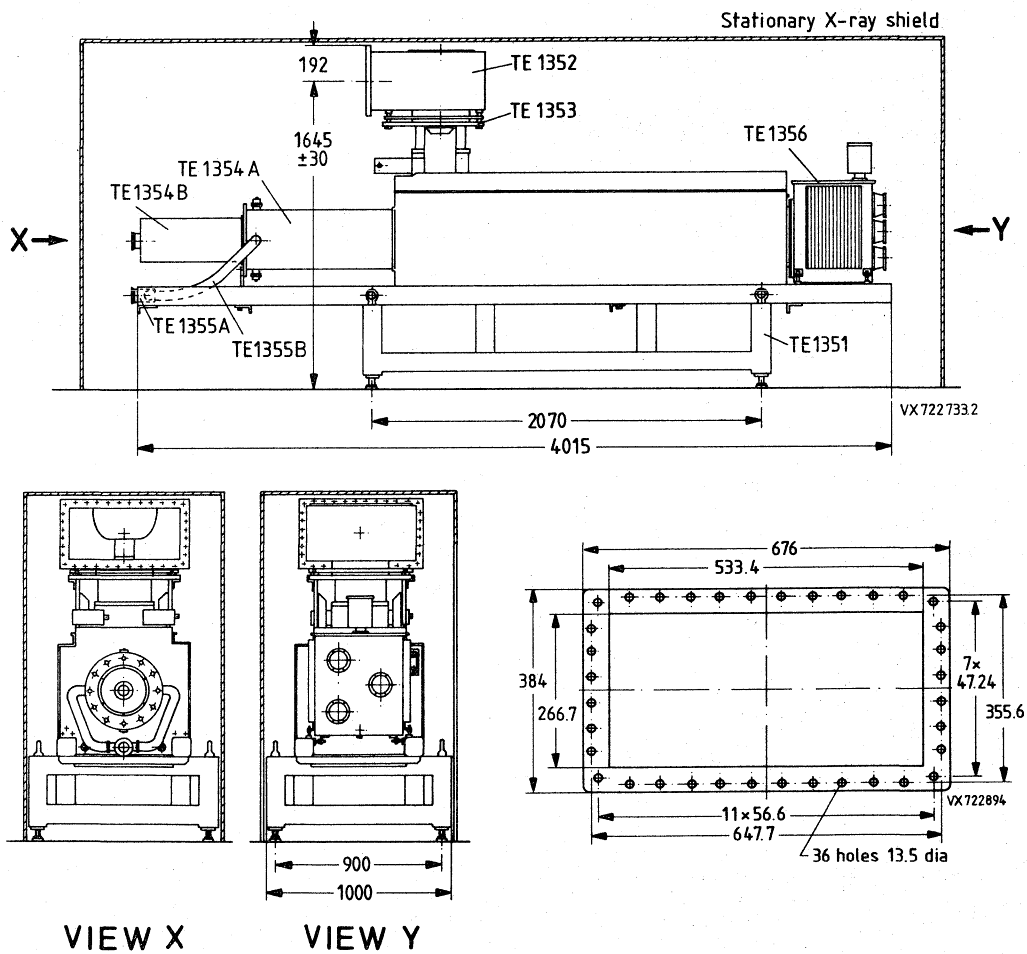


Fig. 2.

* to be defined by user

LIMITING VALUES (Absolute maximum rating system)

Heater voltage Heater current	max. 5 % above specified value given in the acceptance test minutes		
Cathode voltage to body (ground)	max.	−95	kV
Cathode current	max.	22	A
Modulating anode current	max.	5	mA
RF drive power	max.	150	W
CW test output power (for 1 hour)	max.	1.1	MW
Load VSWR	max.	1.3	
Body dissipation	max.	2 x 10	kW
Collector dissipation (with reduced drive)	max.	900	kW *

TYPICAL OPERATING CONDITIONS

1 MW operation into matched load (VSWR < 1.05)

	typ.	
Input power, DC	1510	kW
RF drive power	90	W
Collector dissipation	500	kW
Body dissipation	10	kW
CW output power	1000	kW
Efficiency	66	%
Beam voltage	90	kV
Beam current	16.8	A

PERFORMANCE DATA

Phase shift vs cathode current	< 15	°/A
Phase shift vs rel. cathode voltage	< 15	°/%
Phase shift vs RF drive	< 10	°/dB
RF output vs rel. cathode voltage	< 0.2	dB/%
Signal to noise ratio at saturation	60	dB
Harmonic levels to fundamental at saturation	30	dB
Ratio of fundamental to other discrete frequencies within bandwidth at saturation	70	dB

* 1600 kW can be tolerated without drive for 1 s.
For no-drive operation over extended intervals consult manufacturer.

INSTALLATION AND OPERATION REQUIREMENTS

A. Safety Interlocks

1. Overcurrent and overvoltage (crowbar) protection of the klystron.
   In order to protect the klystron from damage under fault conditions, the customer must supply overcurrent and overvoltage protection.
   Under no circumstances must the energy supplied to the tube exceed 40 joule (or the area under the beam current/time curve ($\int I^2\, dt$) exceed 40 A^2 s).
   Specific crowbar circuit design is the customer responsibility. However the following test should be applied:
   If the klystron is replaced by a piece of copper wire of 0.35 mm diameter and length 1 cm/kV, the chopper wire must not be destroyed if the full beam voltage is applied across the wire.
   The crowbar circuit must be designed to divert any overcurrent from the tube within 100 µs under either of the following conditions:
   - if the beam current increases at a rate greater than 10 A/µs,
   - if the focusing solenoid main-field current deviates more than ± 5 % from the value recorded in the acceptance document.

2. The customer must supply protection circuitry to switch off the beam voltage within 100 ms under any of the following conditions:
   - if the beam current exceeds 22 A or if it increases by more than 2 A above the set value recorded in the acceptance document,
   - if the ion-getter pump current exceeds 10 µA,
   - if the monitored temperatures or temperature differences of the body or collector cooling circuits exceed the limiting values,
   - if the collector temperature measured by the thermocouple exceeds 100 °C,
   - if the flow rate of the collector cooling water falls below 800 litres per minute,
   - if the flow rate of the body cooling water falls below the limiting values,
   - if the air flow rate at the output window falls below 1 m^3 per minute,
   - if the window temperature increase 100 kW of output power exceeds 6 K.

3. Protection of the RF drive to the klystron tube
   The customer must supply protection circuitry to simultaneously disconnect the RF drive (within 10 µs) and switch off or reduce the beam at a constant perveance below 900 kW (within 100 ms) under either of the following conditions:
   - if the arc sensor is activated,
   - if the RF reflection indicator shows a fault condition in the waveguide (VSWR > 1.3).

4. Protection of the filament
   In order to protect the filament from damage under fault conditions, the customer must provide a protection circuit which will switch off the filament supply within 1 second if the ion-getter pump current exceeds 4 mA.

5. Restarting
   After any circuit has tripped under fault conditions, restarting must not take place until at least 10 s have elapsed. Under certain conditions this restart time could be reduced with the permission of the klystron manufacturer.

B. Switching-on and off sequence

Switching-on sequence

It is important that the klystron supplies are switched on in the following sequence, unless otherwise agreed with the klystron manufacturer:

1. Ion-getter pump supplies on.
2. Check the operational value of the pump current (< 10 μA).
3. Filament supply on.
4. Allow at least 15 minutes warm-up period until entering step 11.
5. Connect output window air supply.
6. Connect both body cooling water supplies.
7. Connect collector cooling water supply.
8. Connect focusing solenoid main-field supply.
9. Check that the filament and solenoid current are within ± 1 % of the value given in the acceptance document (or measured before the last switch-off).
10. Connect the RF drive input.
11. Connect the high-voltage cathode (beam) supply and mod. anode supply simultaneously.

Switching-off sequence

1. Switching-off mod. anode high-voltage supply.
2. Switch off the cathode high-voltage supply.
3. Disconnect all other supplies and cooling circuits.

C. Radiation dangers

RF radiation

RF power may be emitted not only through the normal output coupling but also through other apertures (for example RF leaks). This RF power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation will be increased if the tube is functioning incorrectly.
The RF radiation 1 m away from any part of the klystron at 1 MW output power will not exceed 0.1 mW/cm^2.

X-radiation

Due to the high accelerating voltage, the klystron generates a high level of X-rays. Therefore the complete assembly must be shielded during operation in order to reduce the radiation to a non-dangerous level.
The tube manufacturer recommends a shielding made from lead sheets at least 3 mm thick and capable of reducing the X-radiation to a safe level.
The compliance with the local regulations regarding radiation hazards has to be confirmed by the user. If in any doubt refer to your local PHILIPS representative or the manufacturer.
Care must be taken in the construction of this shielding to avoid any holes or slots.

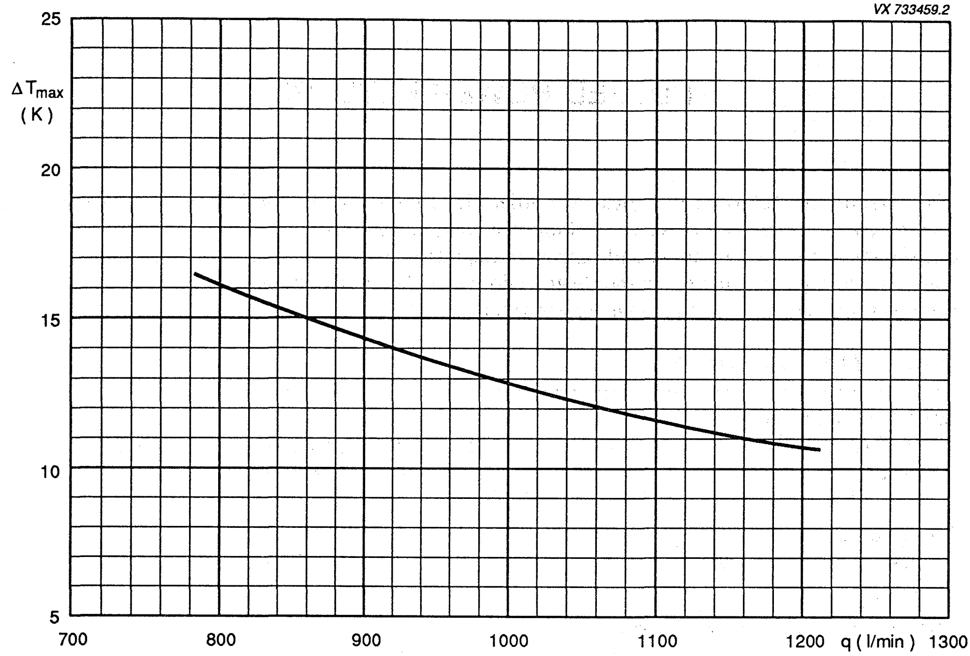


Fig. 3 Maximum difference between inlet and outlet temperature versus collector cooling water flow rates.

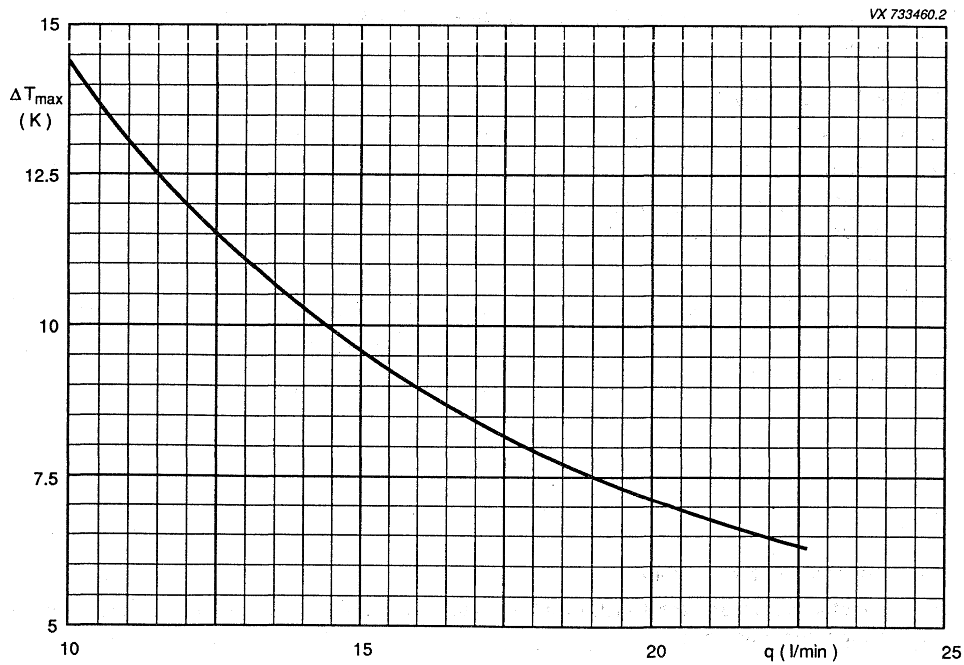


Fig. 4 Maximum difference between inlet and outlet temperature versus body cooling water flow rates.

PULSED POWER KLYSTRONS

Fixed frequency 20 MW pulsed power amplifier klystrons in metal-ceramic construction with 5 internal cavities, electromagnetic focusing, continuously operating getter-ion pump.
Coaxial input connector and S-band output waveguide fitted with a ceramic window.
Water cooling system for r.f. waveguide and window, collector and body.
Intended for use in long-range radar transmitters.

QUICK REFERENCE DATA

Operating frequency			
YK1510	S-band, the klystrons are factory tuned to the specified frequency range		
YK1511			
YK1512			
R.F. output power*			
peak	>	20	MW
average	>	20	KW
Duration of r.f. pulse (—3 dB down)		4	μs
Gain		44	dB

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING, indirect by AC or DC

Heater voltage**	V_F		15 to 30	V
Heater current	I_F		20 to 30	A
Heater supply current at switch-on; the surge current must never exceed a peak value of 50 A.				
Resistance of heater				
cold	R_{fo}	>	0.125	Ω
hot	r_f		0.9 to 1.1	Ω
Waiting time	t_w	min.	12	min

* At least one point in the band.

** The exact value is marked on each tube test report. During operation the heater voltage may not fluctuate more than ±5 %.

MECHANICAL DATA

Dimensions in mm

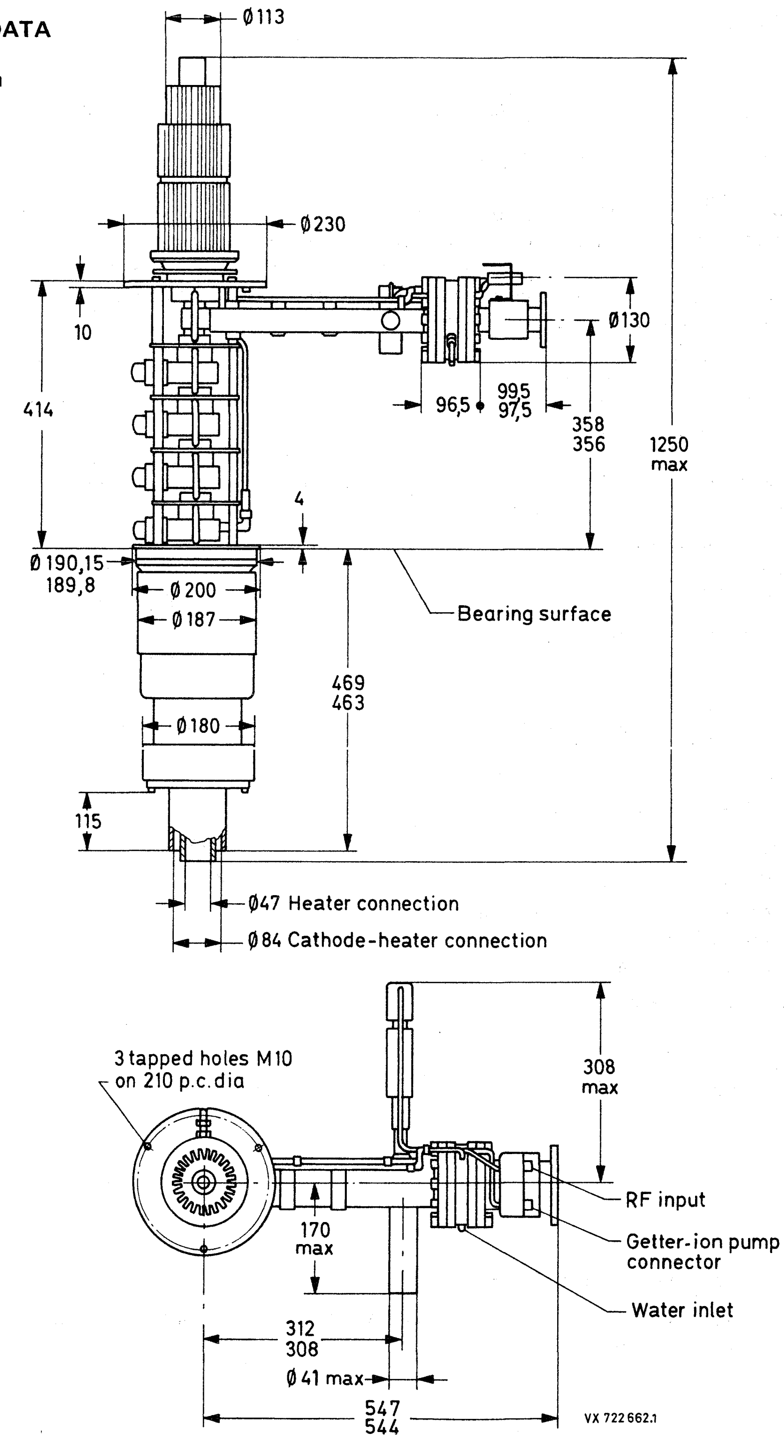


Fig. 1.

MASS (net)	approx.	70	kg

MOUNTING

Mounting position: vertical with collector up

GETTER-ION PUMP POWER SUPPLY

Pump voltage		4.5 to 5.5	kV
Supply current			
tube operating	max.	50	μA
tube turned off	max.	200	mA

ELECTROMAGNET

Current I_1, I_2, I_3	max.	175	A
Impedance of each coil (20 °C)		0.08	Ω

COOLING

Collector, body and window*	min.	max.		
Cooling-water inlet temperature	–	60	°C	
Cooling-water flow	10	–	ℓ/min	
Cooling-water inlet pressure	–	1000	kPa	(= 10 bar)
Cooling-circuit pressure drop	–	600	kPa	(= 6 bar)
Electromagnet	min.	max.		
Water flow	13	–	ℓ/min	
Water inlet pressure	–	1000	kPa	(= 10 bar)
Water inlet temperature	–	60	°C	

* By means of a single water circuit.

LIMITING VALUES (Absolute maximum rating system)

Beam voltage, peak	max.	270	kV	
Beam current, peak	max.	275	A	
R.F. input power				
peak	max.	5	kW	
average	max.	10	W	
R.F. output power				
peak	max.	23	MW	
average	max.	23	kW	
Load VSWR	max.	1.4		
Collector dissipation	max.	80	kW	
Voltage pulse duration (measured at 70 %)	max.	6	μs	
Duty factor	max.	0.003		
Pressure on the output window	max.	1300	kPa	(= 13 bar)
	min.	1100	kPa	(= 11 bar)

PRODUCT SAFETY

1. X-radiation

Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.

The operating tube generates X-rays which can penetrate the ceramic parts of the tube envelope. In order to reduce the radiation at any accessible points to an officially acceptable, non-dangerous level the tube must be shielded and any possible radiation path blocked by at least 1 mm of brass or an equivalent depth of non-magnetic X-ray absorbing material. The proper use of our accessories will provide the necessary shielding.

2. R.F. radiation

R.F. power may be emitted through apertures other than the normal output coupling (for example r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

TYPICAL OPERATING CONDITIONS

Measured under matched load conditions (VSWR $\leqslant 1.1$)

Operating frequency*				S-Band	
Bandwidth (−1 dB)				100	MHz
Beam voltage				240	kV
Beam current				254	A
R.F. input power, peak				1	kW
Operating mode	A	B	C		
Output power					
peak	20	10	10		MW
average	20	20	10		kW
R.F. pulse duration (−3 dB)	4	4	4		μs
Pulse repetition rate	250	500	250		Hz
Duty factor	0.001	0.002	0.001		
Gain				44	dB
Efficiency				> 30	%
Perveance				2.0 to 2.3	$\mu A \cdot V^{-3/2}$

* The tube is tuned to a fixed frequency at the factory.

PULSED POWER KLYSTRON

Fixed frequency, pulsed power klystron in metal-ceramic construction for S-band with 5 internal cavities, electromagnetic focusing, continuously operating getter-ion pump.
Coaxial input connector and r.f. output split into two parallel waveguide arms with two r.f. ceramic windows.
Water cooling systems for r.f. windows, collector and body.
Intended for use for linear particle accelerator applications.

QUICK REFERENCE DATA

Frequency (fixed tuned)	f		2998.5	MHz
R.F. pulse width (at −3 dB)			4.5	μs
R.F. output power				
peak	W_{op}	⩾	35	MW
average	W_o	⩾	15.75	kW
Gain	G	⩾	52	dB
Efficiency	η	⩾	45	%

This data must be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS for KLYSTRONS.

HEATING: indirect by AC

Cathode	long life oxide type				
		min.	typ.	max.	
Heater voltage *	V_f	17	20	25	V
Heater current	I_f	18	21	24	A
Cold heater resistance (20 °C)	R_{fo}	–	125	–	mΩ
Waiting time	t_w	15	–	–	minutes

ION-GETTER PUMP SUPPLY

Pump voltage		–	–	5	kV

* The actual value is marked on each tube test report.

MECHANICAL DATA

Dimensions in mm

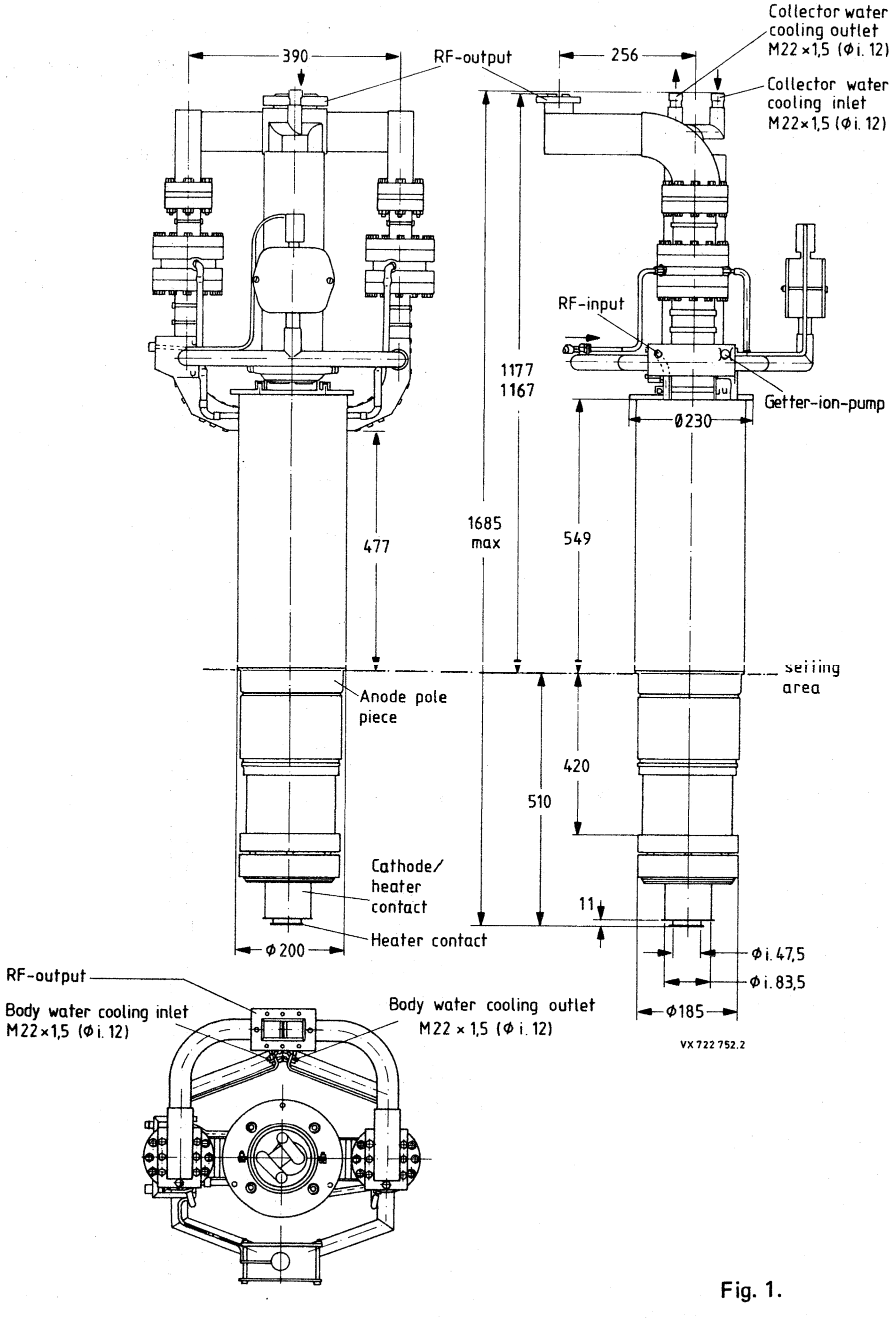


Fig. 1.

DEVELOPMENT DATA

COOLING

	min.	typ.	max.		
Collector					
demineralized or distilled water with 10% stabilized glycol added	–	60	–	ℓ/min	
pressure drop	–	70	–	kPa	(= 0.7 bar)
Body circuit					
demineralized or distilled water with 10% stabilized glycol added	–	10	–	ℓ/min	
pressure drop	–	170	–	kPa	(= 1.7 bar)
Focusing coils					
demineralized or distilled water with 10 % stabilized glycol added	–	100	–	kPa	(= 1 bar)

MASS

Net mass YK1600, incl. combiner	120 kg
Magnet trolley	450 kg
X-ray shield collector	170 kg
X-ray shield body	300 kg

DIMENSIONS

Tube and mounting frame — see drawing

MOUNTING

vertical, cathode down

R.F. CONNECTORS

Input	N-type, female
Output	waveguide, LIL-Flange V.W. 31 1240–2

CONNECTOR GETTER-ION PUMP

HN-type, female

ACCESSORIES

R.F. power combiner	TE1610
Focusing magnet	TE1612
Counter coil	TE1613
X-ray shield for body	TE1620
X-ray shield for collector	TE1621
Transport trolley klystron	TE1630
Lifting yoke for klystron	TE1631
Lifting device for collector shield	TE1632
Lifting device for magnet	TE1633
Magnet trolley	TE1634

LIMITING VALUES (Absolute maximum rating system)

Heater voltage	max.	25	V
Heater current	max.	24	A
Cathode voltage, peak	max.	300	kV
Cathode current, peak	max.	300	A
Collector dissipation	max.	80	kW
R.F. drive power			
peak	max.	1000	W
average	max.	10	W
R.F. pulse width	max.	6	μs
H.V. pulse width	max.	7	μs
Load VSWR			
for normal operation	max.	1.15	
permissable value *	max.	1.5	
Pressure on r.f. output windows SF_6	max.	550	kPa (5.5 bar)

* Without destruction of the tube.

DEVELOPMENT DATA

TYPICAL OPERATING CONDITIONS

Frequency	2998.5	MHz
Heater current	21	A
Heater power	420	W
Preheating time cathode	15	minutes
Supply voltage of getter-ion pump	5	kV
Load VSWR	⩽ 1.04	
Cathode voltage, peak	270	kV
Cathode current peak	280	A
Bandwidth (−1dB)	⩾ 10	MHz
Perveance	2	$\mu A/V^{3/2}$
R.F. drive power, peak	175	W
R.F. pulse width at −3 dB	4.5	μs
Pulse repetition rate	100	Hz
Pressure on r.f. output windows SF_6	550	kPa (5.5 bar)
R.F. output power		
peak	35	MW
average	15.75	kW
Gain	53	dB
Efficiency	⩾ 45	%
Dissipation on klystron body	⩽ 2	kW

PRODUCT SAFETY

R.F. radiation

R.F. power may be emitted not only through the normal output coupling but also through other apertures (for example, r.f. leaks). This r.f. power may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the tube is functioning incorrectly.

X-radiation

A highly dangerous intensity of X-rays may be emitted by tubes operating at voltages higher than approximately 5 kV. Adequate protection (X-ray shielding) for the operator is then necessary. The emission intensity of X-rays may correspond to a value of voltage much higher than that expected from the actual value applied to the tube.

Poor focusing may result in excessive X-radiation.

This tube and accessories are equipped with a lead shielding which under normal conditions reduces the radiation values below 2.5 mR/h, measured at a distance of 0.4 m from the tube assembly.

ACCESSORIES
FOR UHF POWER KLYSTRONS

ACCESSORIES FOR UHF POWER KLYSTRONS

type		klystron type YK1220/23 YK1221	YK1230/33 YK1234/35	YK1263/65 YK1267	YK1270/73	page
TE1107	Arc detector	X	X	—	—	251
TE1107B	Arc detector	X	X	X	X	252
TE1107C	Arc detector	X	X	X	X	253
TE1107Z	Arc detector interconnection	X	X	X	X	254
TE1110B	Boiler for vapour cooling	—	—	X	—	255
TE1110H	Boiler for vapour cooling	—	—	X	—	256
TE1141	Accelerator electrode ring	—	—	X	—	257
TE1142B	Cathode ring	—	—	X	—	258
TE1146	Set of connectors	—	—	X	—	259
TE1180	Magnet frame with coils	—	—	—	X	261
TE1182B	Collector radiation suppressor	X	X	—	—	263
TE1183	Spark gap	X	X	X	—	264
TE1184	Set of connectors	X	X	—	X	265
TE1185	Cavity	X	X	—	X	267
TE1185T	Cavity, temp. compensated	X	X	—	X	268
TE1186F	Input and load coupler for direct control	X	X	—	X	269
TE1187A	Output coupler 1 5/8" for front panel control	X	—	—	X	270
TE1187B	Output coupler 1 5/8" for direct control	X	—	—	X	271
TE1187C	Output coupler 3 1/8" for direct control	X	X	—	X	272
TE1187R	Coupling loop	X	X	—	X	273
TE1187S	Coupling loop	X	X	—	X	273
TE1188	Magnet frame with coils	X	X	—	—	275
TE1189A	Collector cooling jacket	X	—	—	—	277
TE1189B	Collector cooling jacket	—	X	—	—	278
TE1189C	Boiler for vapour cooling	X	—	—	—	279
TE1189D	Boiler for vapour cooling	—	X	—	—	281
TE1189G	Collector cooling jacket	—	X	—	—	283
TE1190	Tool set	X	X	X	X	284
TE1194B	Collector cooling jacket	—	—	X	—	285
TE1199	Temperature sensor PT-100	X	X	X	—	286
TE1221	Collector radiation suppressor	—	—	X	—	287

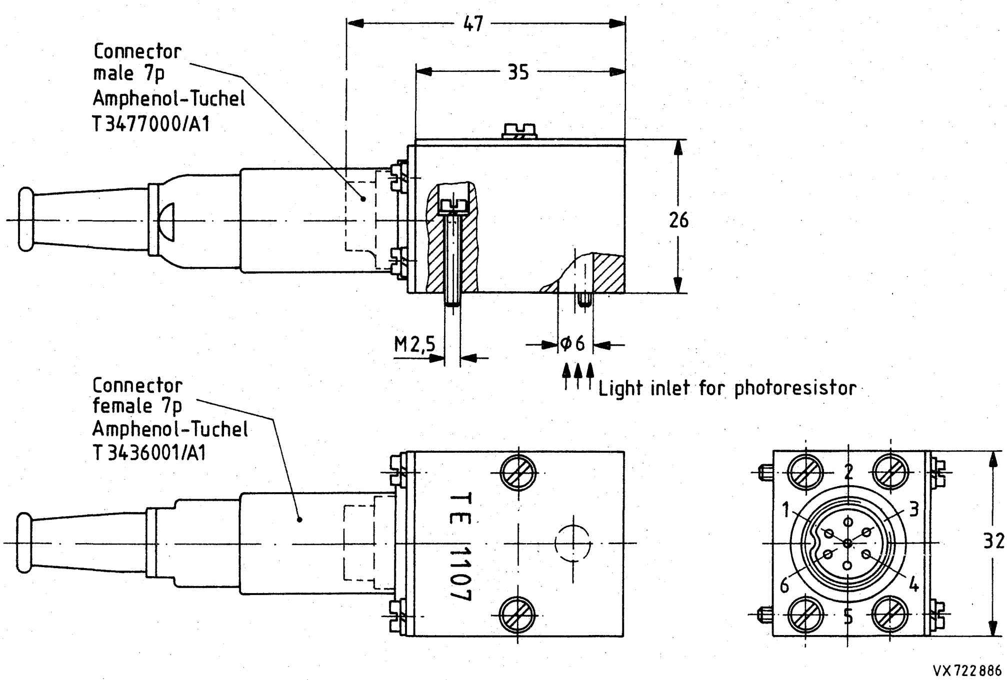
type		klystron type				page
		YK1220/23 YK1221	YK1230/33 YK1234/35	YK1263/65 YK1267	YK1270/73	
TE1222	Magnet frame with coils	—	—	X	—	289
TE1224	Cavity	—	—	X	—	291
TE1225	Cavity, continuously tunable	—	—	X	—	292
TE1226D	Front panel drive	X	X	X	X	293
TE 1226F	Input and load coupler for direct control	—	—	X	—	294
TE1227	Output coupler 3 1/8" for direct control	—	—	X	—	295
TE1285	Cavity, continuously tunable	X	X	—	X	296
TE1289	Collector cooling air duct	—	—	—	X	297
TE1290	Tool set	X	X	X	X	298
TE1291	Tuning crank	X	X	X	X	299
TE1292	Tuning knob	X	X	X	X	300

ARC DETECTOR

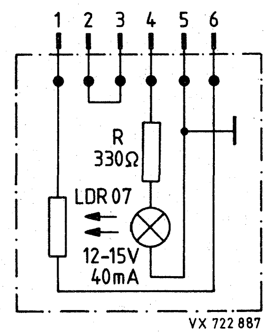
for YK1190...YK1198, (YK1220/21/23, YK1230/33/34/35), YK1290...YK1297
used with cavities TE1098D, TE1121D, TE1191B, (TE1185B)

MECHANICAL DATA

Dimensions in mm



ELECTRICAL DATA

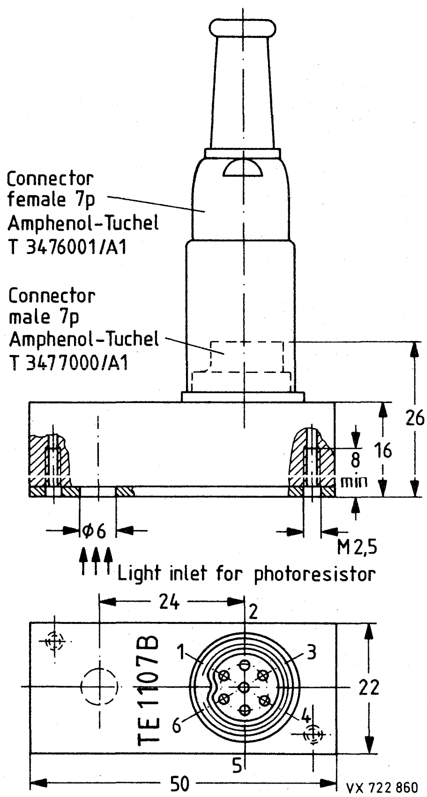


ARC DETECTOR

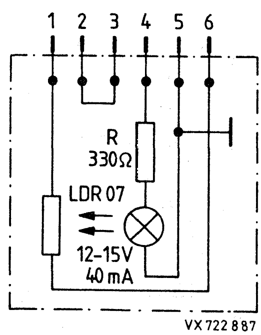
for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1185, TE1185T, TE1224

MECHANICAL DATA

Dimensions in mm



ELECTRICAL DATA

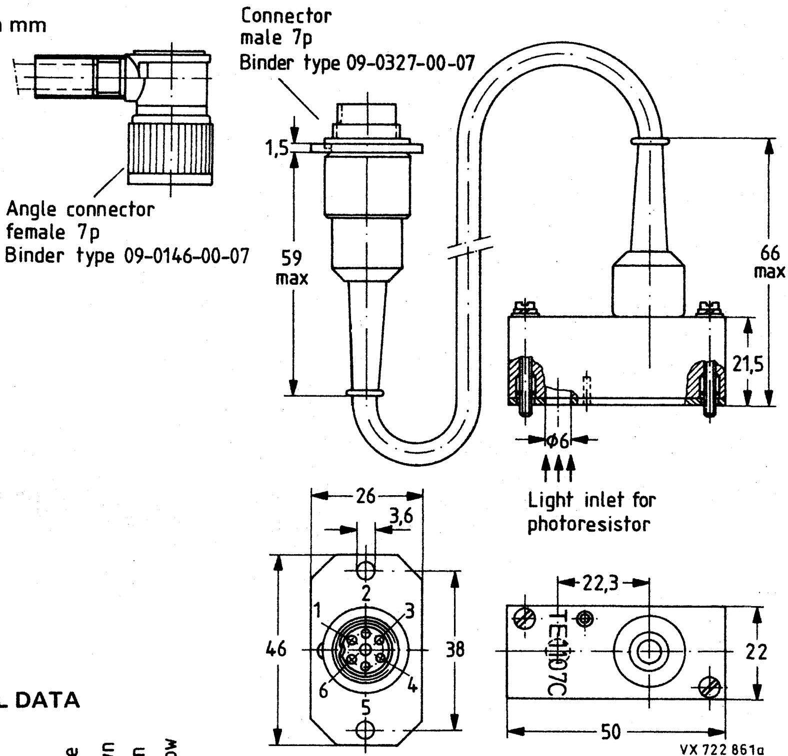


ARC DETECTOR

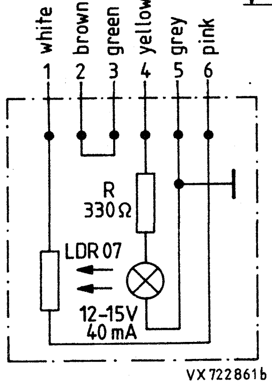
for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1225, TE1285

MECHANICAL DATA

Dimensions in mm

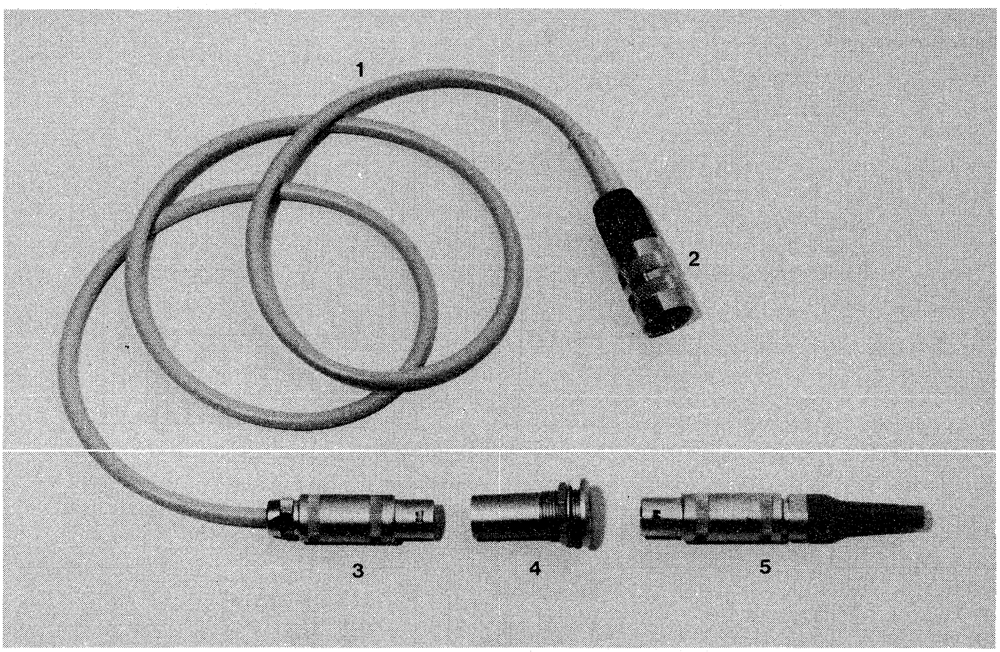


ELECTRICAL DATA



ARC DETECTOR INTERCONNECTION

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
optional for arc detector TE1107B
in combination with cavities TE1185, TE1185T, TE1224



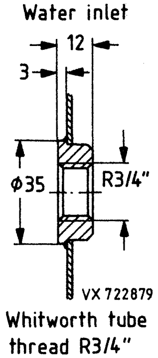
1 Cable, length 850 mm
2 Connector Amphenol-Tuchel 7pol. T3476001/A1
3 Connector LEMOSA F2S306N/NG5.7
4 Connector LEMOSA RADV 2306
5 Connector LEMOSA F2S306N/NG

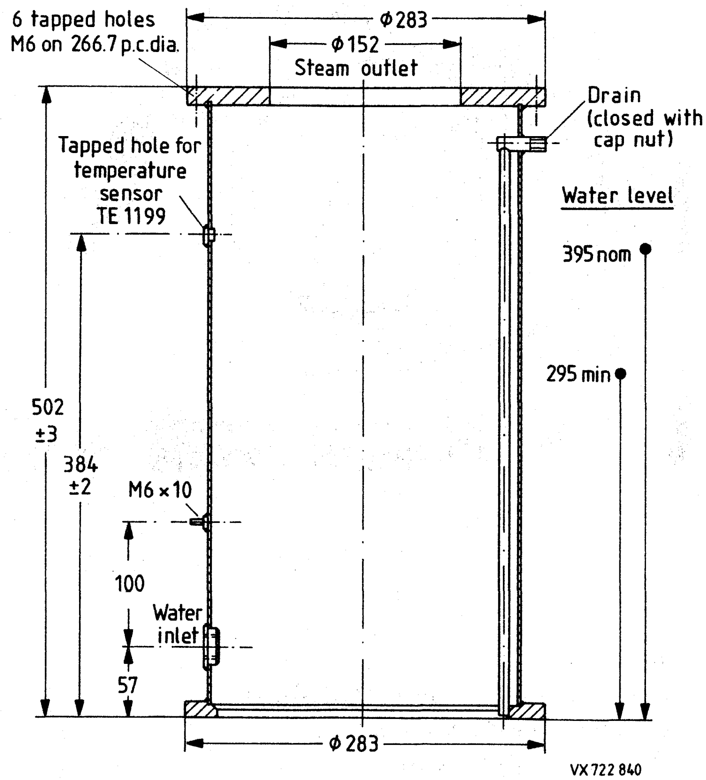
BOILER
FOR VAPOUR COOLING

for YK1263/65/67

MECHANICAL DATA Dimensions in mm

Mass (net) approx. 12 kg





Sealing rings, bolts, etc. supplied with boiler.

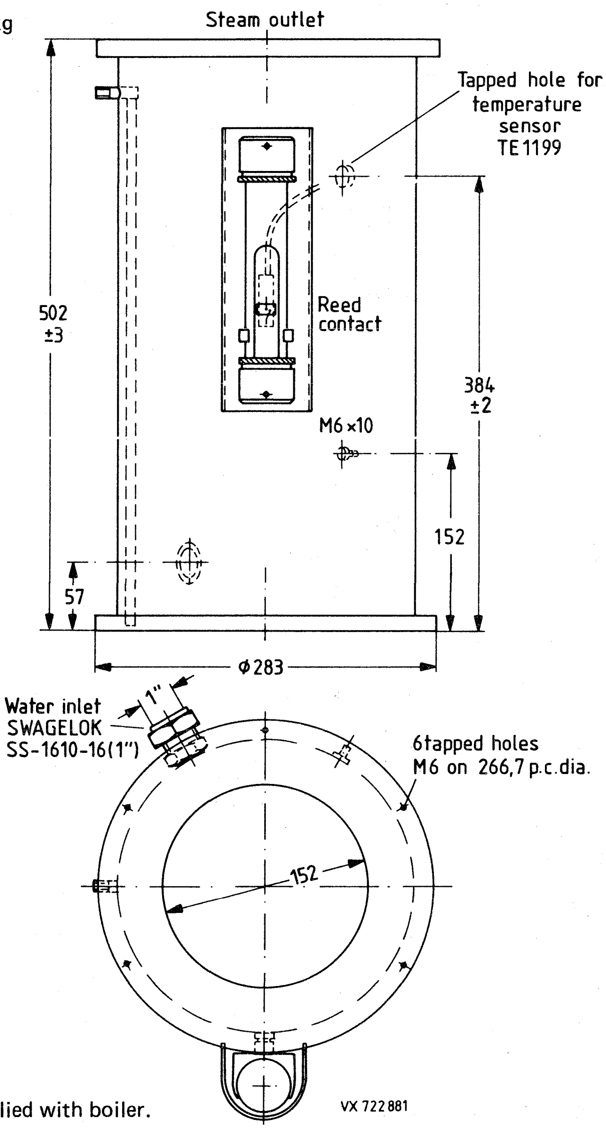
BOILER
FOR VAPOUR COOLING

with sight glass and level control
for YK1263/65/67

MECHANICAL DATA

Dimensions in mm

Mass (net) approx. 15 kg



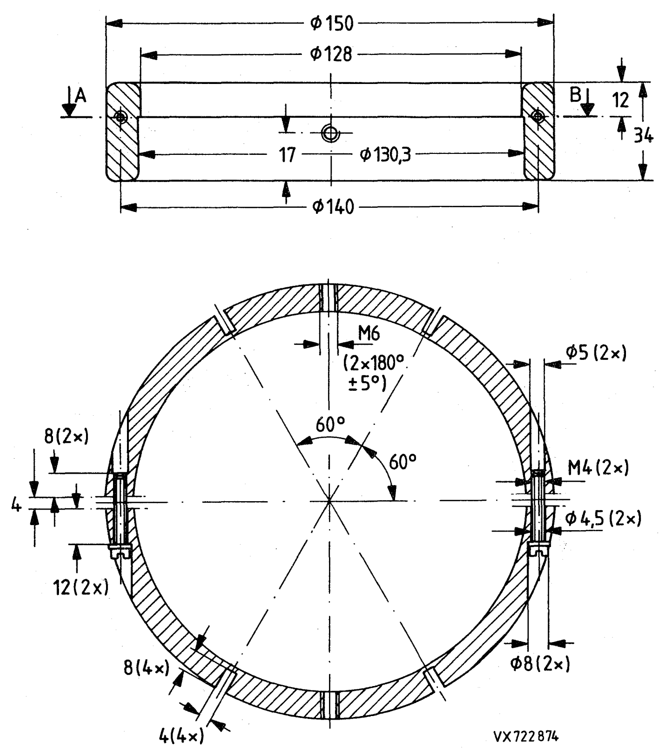
Sealing rings, bolts, etc. supplied with boiler.

ACCELERATOR ELECTRODE RING

for YK1190...YK1198, YK1263/65/67, YK1290...YK1297

MECHANICAL DATA

Dimensions in mm

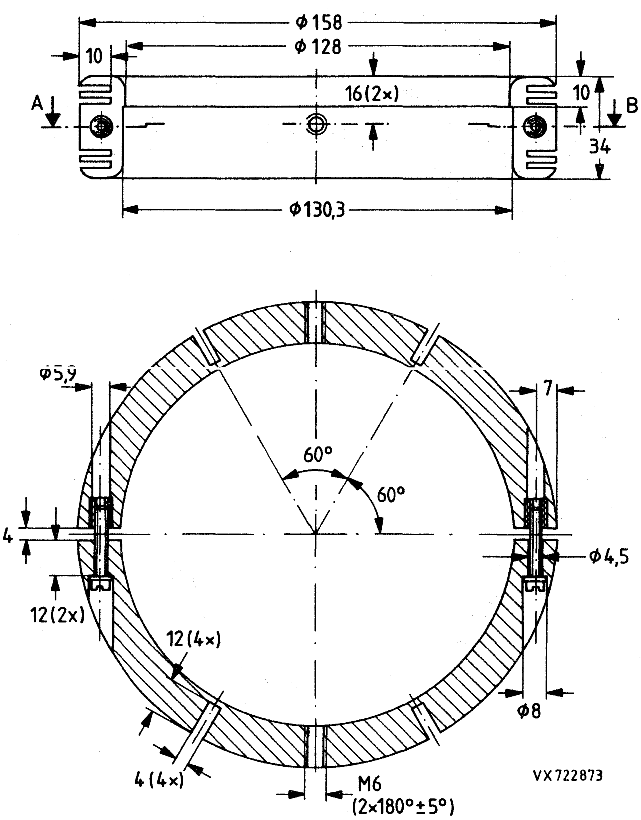


Screw M6 x 10 and washer supplied with accelerator electrode ring.

CATHODE RING

for YK1190...YK1198, YK1263/65/67, YK1290...YK1297

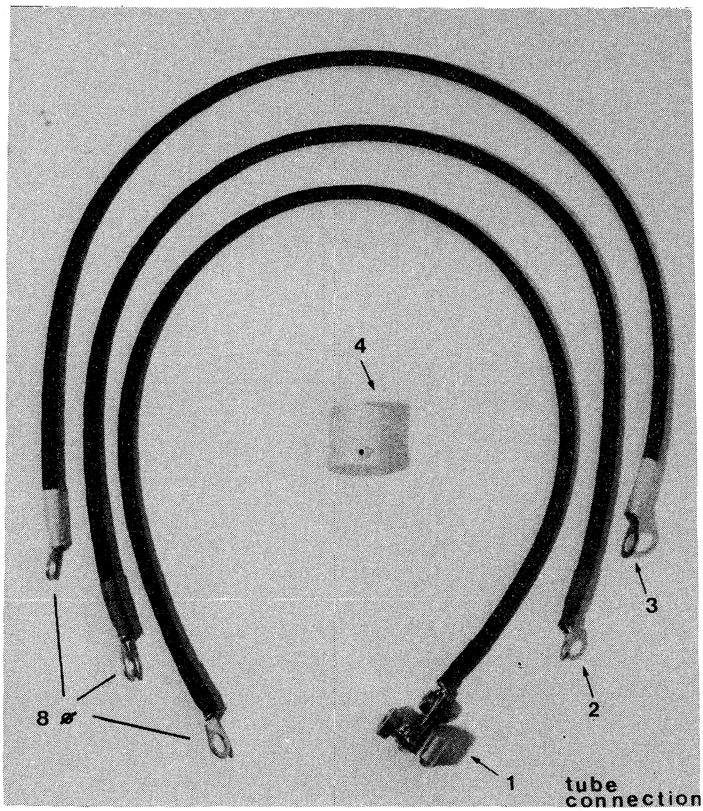
MECHANICAL DATA Dimensions in mm



Screw M6 x 10 and washers supplied with cathode ring.

SET OF CONNECTORS

(heater, cathode, accelerator electrode, ion-getter pump)
for YK1190...YK1198, YK1263/65/67, YK1290...YK1297



1 Heater connection cable (blue), lenghth 540 mm, with heater clamp (Ø 10.5 mm), see next page type 40649.

2 Heater/cathode connection cable with clamp (red), length 540 mm.

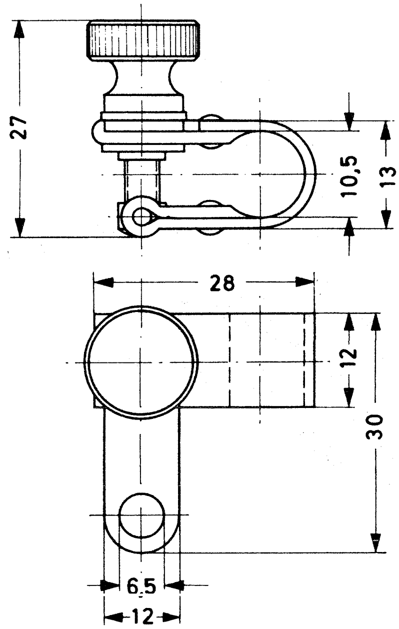
3 Modulating anode connection cable (yellow), length 540 mm.

4 Anode cap for ion-getter pump, solder tap connection.

HEATER CLAMP 40649
for 10.5 mm dia. terminals

Material: brass, nickel plated

Dimensions in mm



MAGNET FRAME WITH COILS

for YK1270/73

MASS AND DIMENSIONS

TE1180 in plastic cover, mounted on pallet

net	approx. 230	kg
gross	approx. 260	kg
outline dimensions of packing (mm)	1200 x 1000 x 1280	

TE1180 in wooden box, mounted on pallet

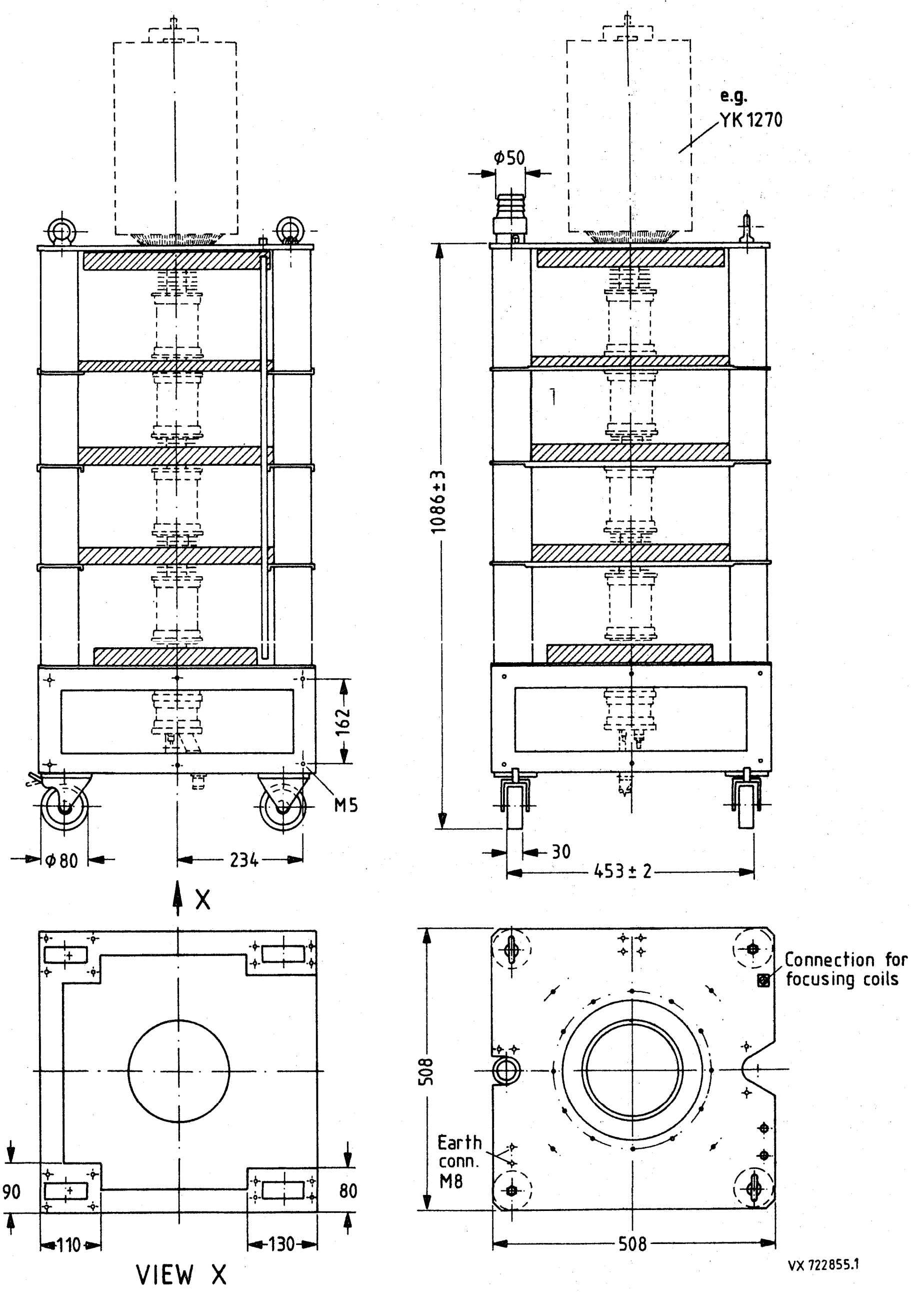
net	approx. 230	kg
gross	approx. 330	kg
outline dimensions of packing (mm)	1200 x 1000 x 1310	

Outlines see next page

MECHANICAL DATA

Outlines

Dimensions in mm

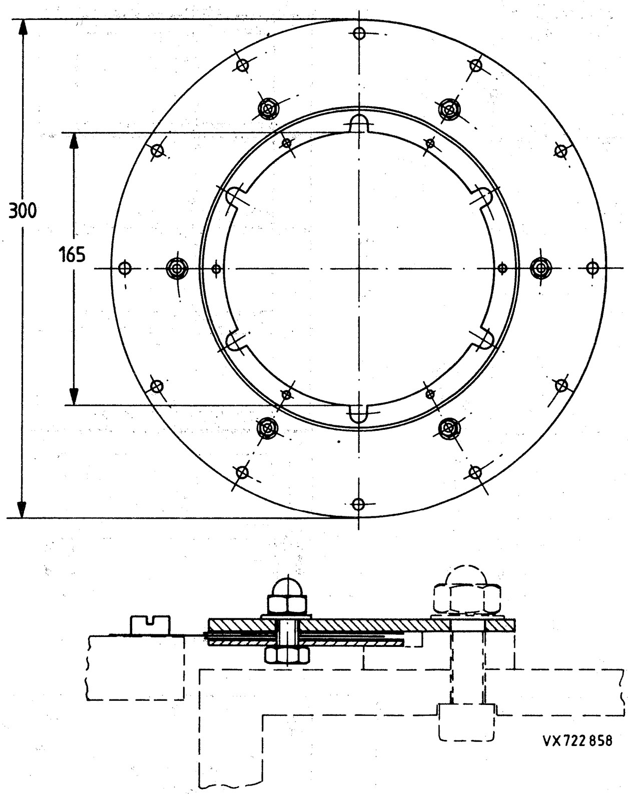


COLLECTOR RADIATION SUPPRESSOR

for YK1220/21/23, YK1230/33/34/35

MECHANICAL DATA

Dimensions in mm

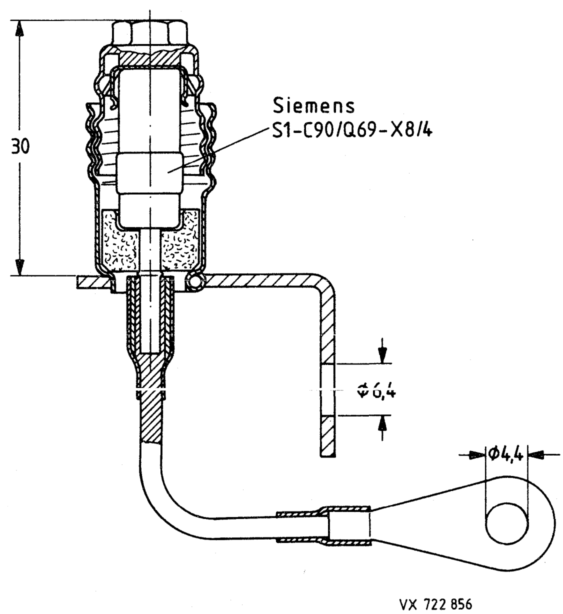


SPARK GAP

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67

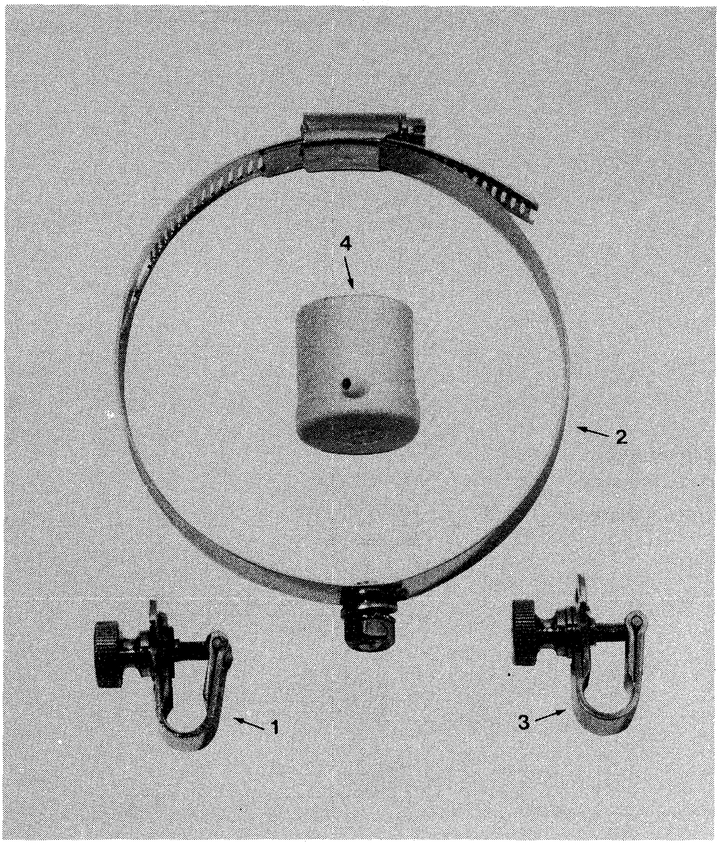
MECHANICAL DATA

Dimensions in mm



SET OF CONNECTORS

(heater, cathode, accelerator electrode, ion-getter pump)
for YK1220/21/23, YK1230/33/34/35, YK1270/73



1 Heater/cathode clamp (9 mm dia.), see next page type 40634.

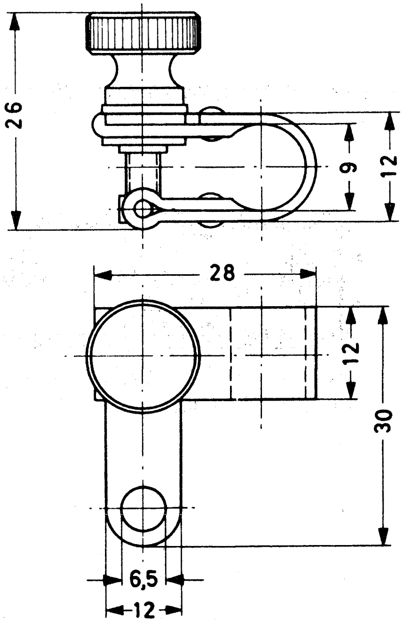
2 Accelerator electrode clamp connection (screw M6).

3 Heater clamp connection (10.5 mm dia.), see next page type 40649.

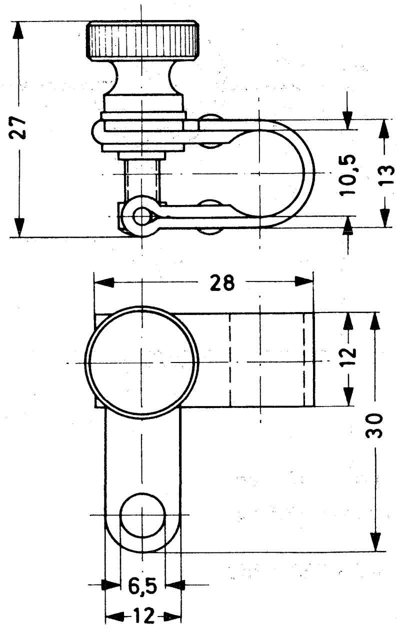
4 Anode cap for ion-getter pump, solder tap connection.

HEATER/CATHODE CLAMP 40634
for 9 mm dia. terminals
Material: brass, nickel plated

Dimensions in mm



HEATER CLAMP 40649
for 10.5 mm dia. terminals
Material: brass, nickel plated

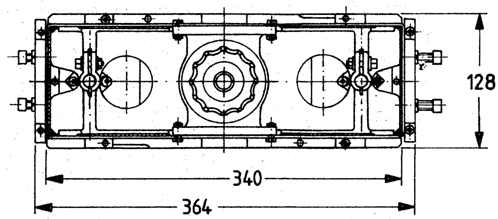


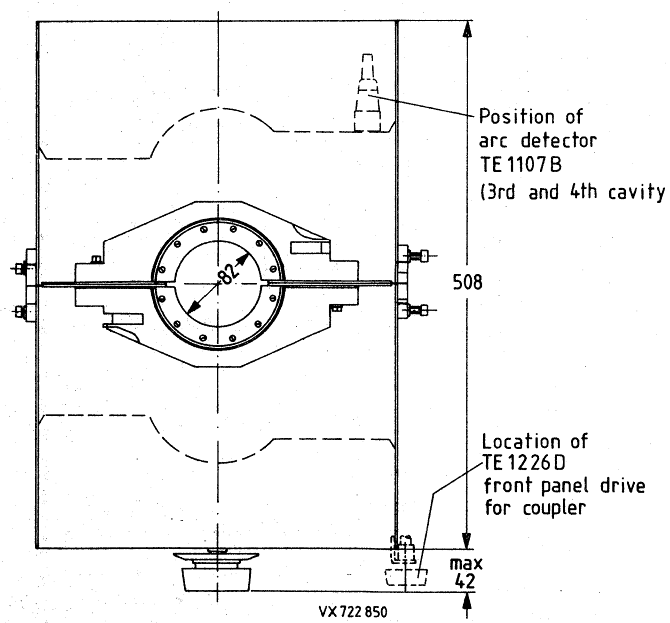
CAVITY

for YK1220/21/23, YK1230/33/34/35, YK1270/73

MECHANICAL DATA

Dimensions in mm





MASS AND DIMENSIONS

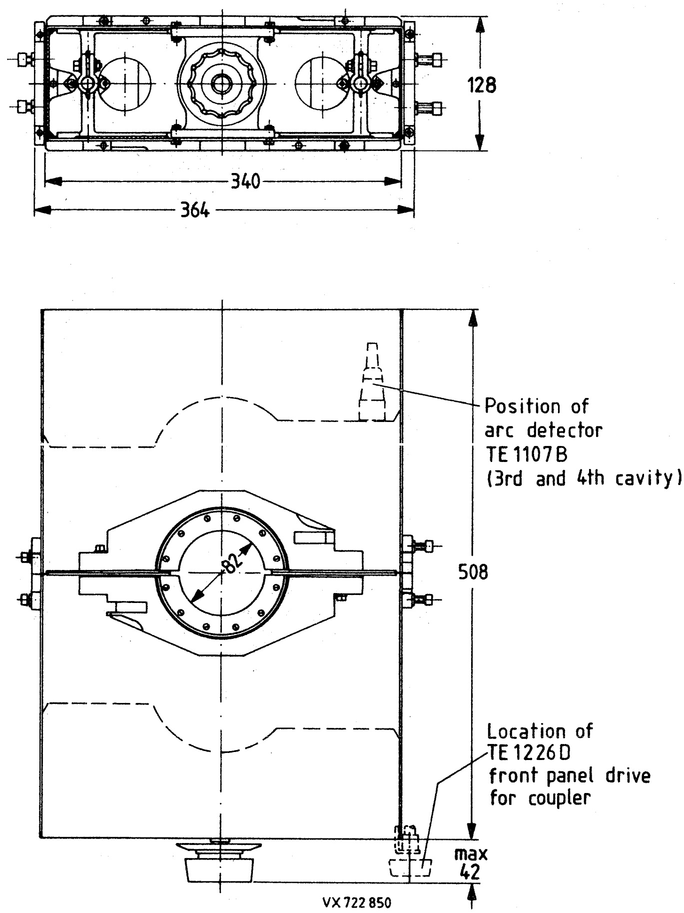
net	approx. 15 kg
gross	approx. 18.5 kg
outline dimensions of packing (mm)	680 x 520 x 250

CAVITY
TEMPERATURE COMPENSATED

for YK1220/21/23, YK1230/33/34/35, YK1270/73

MECHANICAL DATA

Dimensions in mm



MASS AND DIMENSIONS

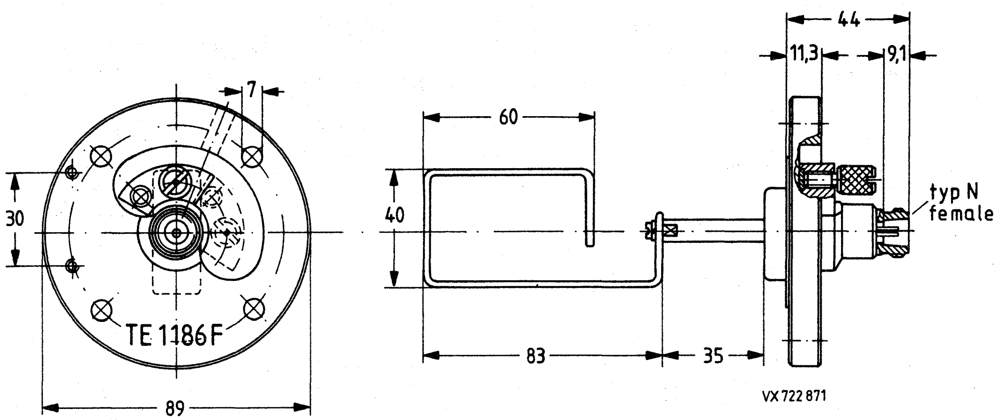
net	approx. 16 kg
gross	approx. 19.5 kg
outline dimensions of packing (mm)	680 x 520 x 250

INPUT AND LOAD COUPLER FOR DIRECT CONTROL

for YK1220/21/23, YK1230/33/34/35, YK1270/73
used with cavities TE1185, TE1185T, TE1285

MECHANICAL DATA

Dimensions in mm



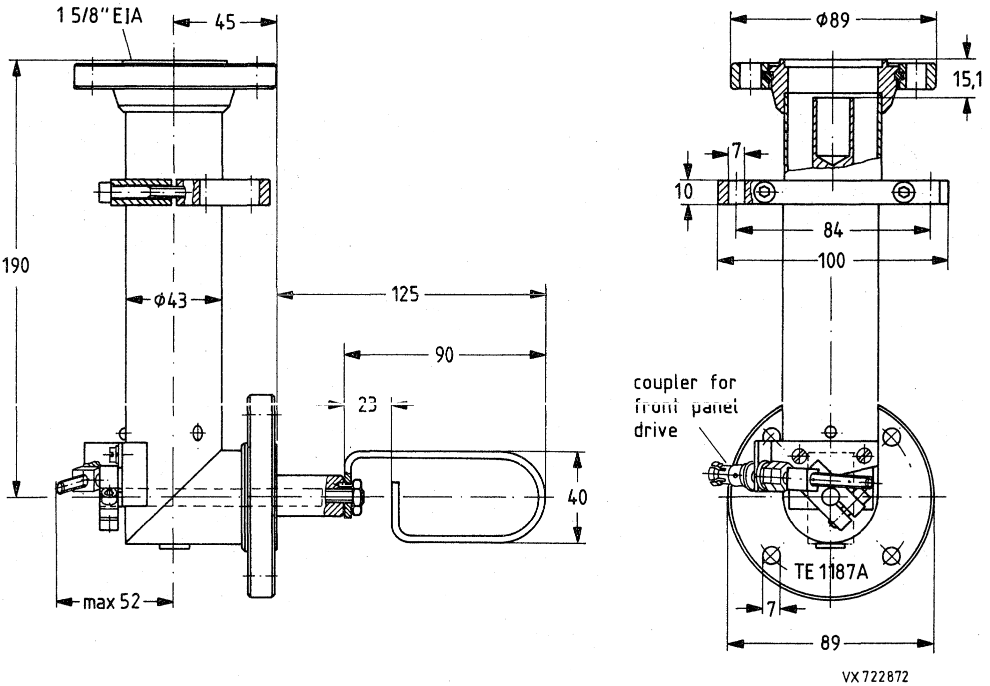
For front panel control TE1226D is additionally needed.

OUTPUT COUPLER 1 5/8" FOR FRONT PANEL CONTROL

for YK1220/21/23, YK1270/73
used with cavities TE1185, TE1185T, TE1285

MECHANICAL DATA

Dimensions in mm



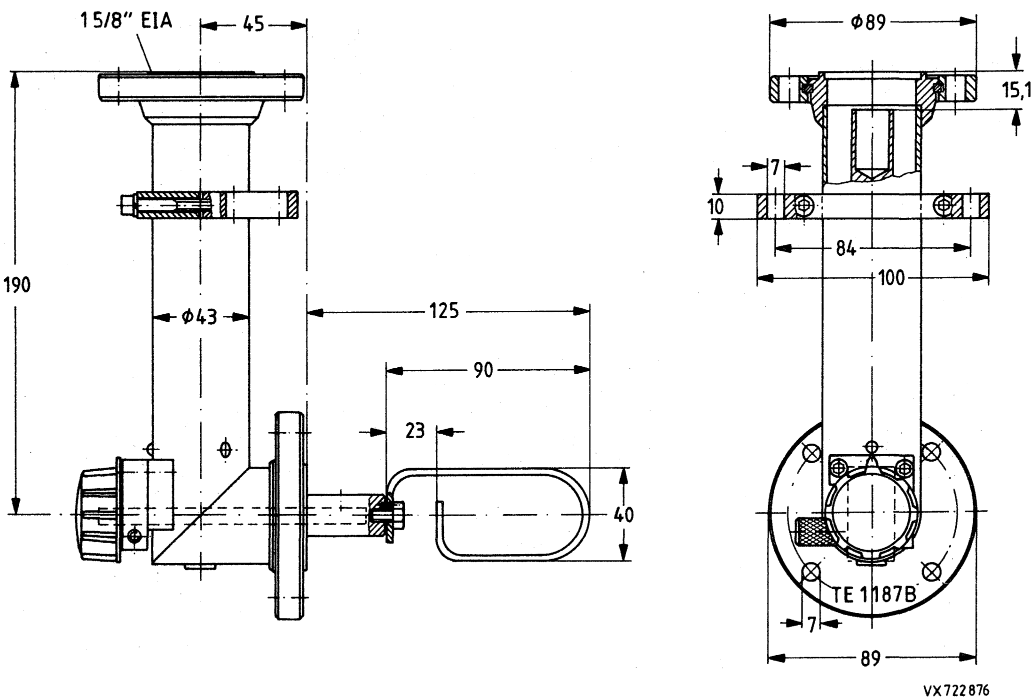
NOTE
Front panel drive included.
The output coupler is supplied with a standard loop. For certain channels optional coupling loops TE1187R or TE1187S are required.

OUTPUT COUPLER 1 5/8" FOR DIRECT CONTROL

for YK1220/21/23, YK1270/73
used with cavities TE1185, TE1185T, TE1285

MECHANICAL DATA

Dimensions in mm



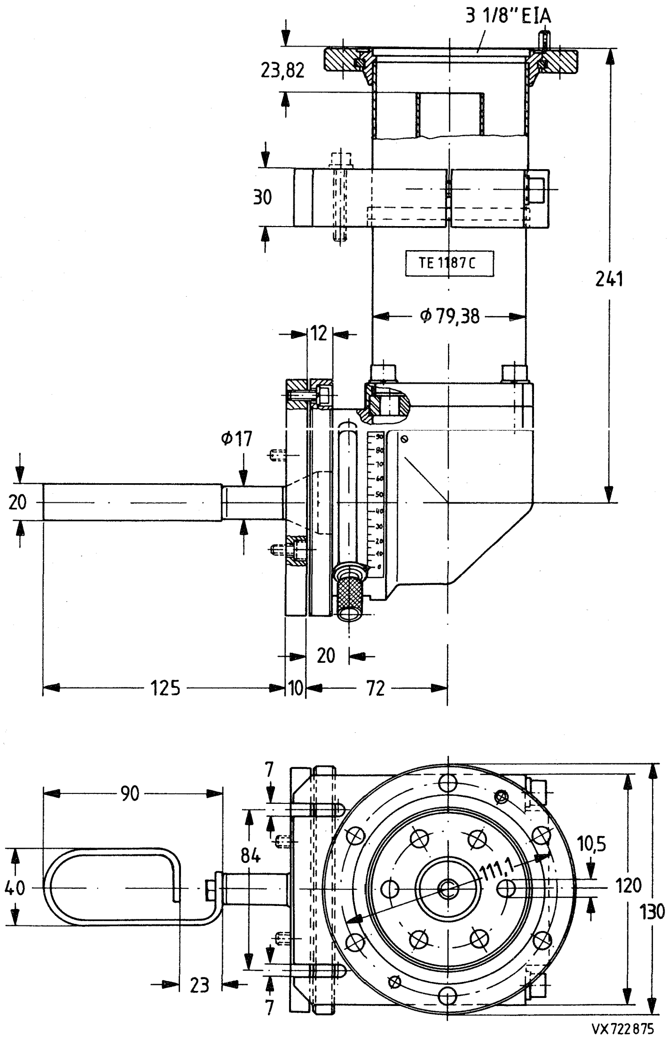
NOTE
The output coupler is supplied with a standard loop. For certain channels optional coupling loops TE1187R or TE1187S are required.

OUTPUT COUPLER 3 1/8" FOR DIRECT CONTROL

for YK1220/21/23, YK1230/33/34/35, YK1270/73
used with cavities TE1185, TE1185T, TE1285

MECHANICAL DATA

Dimensions in mm



NOTE
The output coupler is supplied with a standard loop. For certain channels optional coupling loops TE1187R or TE1187S are required.

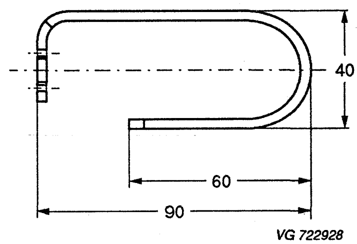
COUPLING LOOPS

for YK1220/21/23, YK1230/33/34/35, YK1270/73
used with output couplers TE1187A, TE1187B, TE1187C

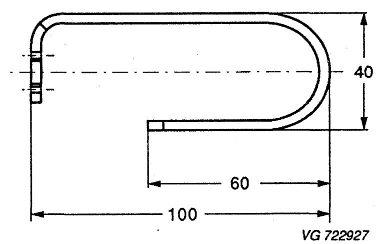
MECHANICAL DATA

Dimensions in mm

TE1187R



TE1187S



The output couplers TE1187A/B/C comprise a standard loop (Type No 1). For certain channels special (optional) coupling loops are required.

TE1187R (Type No 2)	for vision/sound operation at channel 32/31 (8 MHz raster) resp. 28, 29/28 (6 MHz raster)
TE1187S (Type No 3)	for operation above channel 62 (8 MHz raster) resp. 68 (6 MHz raster)

MAGNET FRAME WITH COILS

for YK1220/21/23, YK1230/33/34/35

MASS AND DIMENSIONS

TE1188 in plastic cover, mounted on pallet

net	approx. 230	kg
gross	approx. 260	kg
outline dimensions of packing (mm)	1200 x 1000 x 1280	

TE1188 in wooden box, mounted on pallet

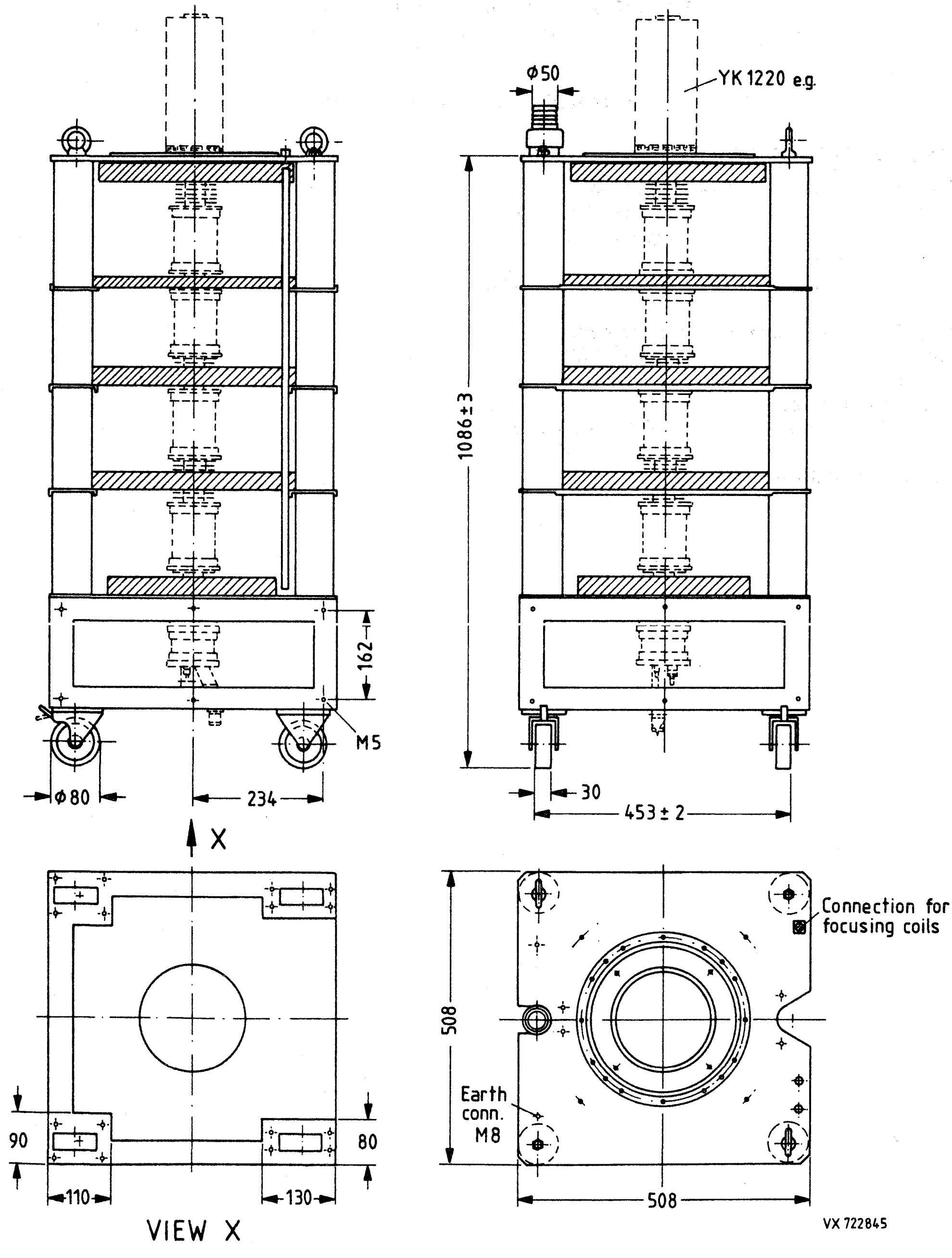
net	approx. 230	kg
gross	approx. 330	kg
outline dimensions of packing (mm)	1200 x 1000 x 1310	

Outlines see next page

MECHANICAL DATA

Outlines

Dimensions in mm



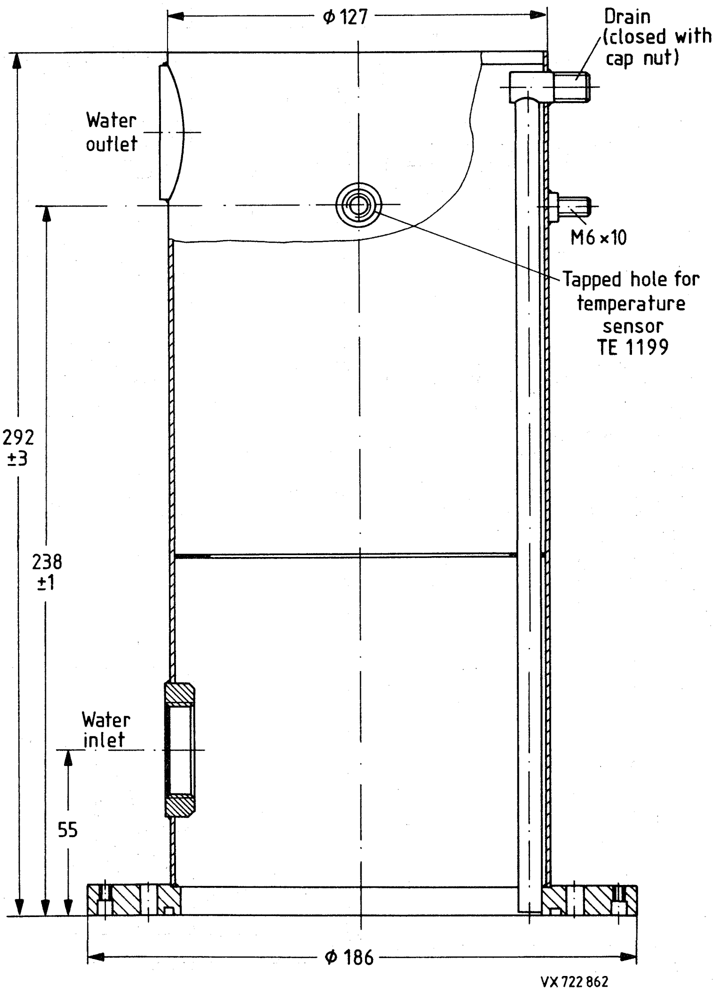
COLLECTOR COOLING JACKET FOR WATER OR VAPOUR CONDENSATION COOLING

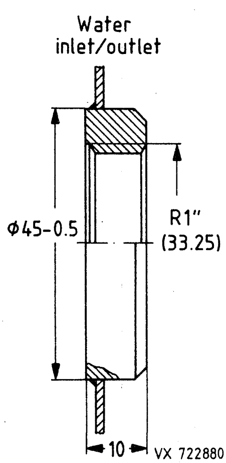
for YK1220/21/23

MECHANICAL DATA

Dimensions in mm

Mass (net) approx. 3.5 kg





Whitworth tube thread R1″

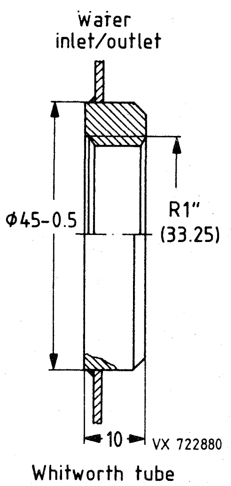
Sealing rings, bolts, etc. supplied with collector cooling jacket.

COLLECTOR COOLING JACKET FOR WATER OR VAPOUR CONDENSATION COOLING

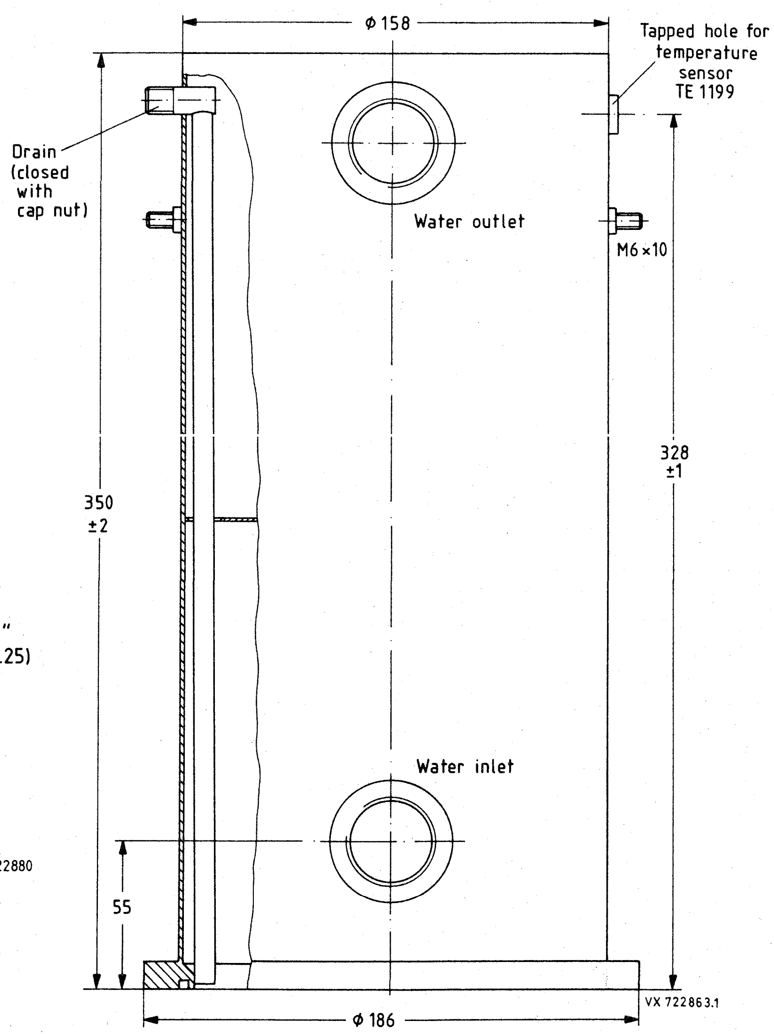
for YK1230/33/34/35

MECHANICAL DATA

Dimensions in mm



Whitworth tube thread R1"



Sealing rings, bolts, etc. supplied with collector cooling jacket.

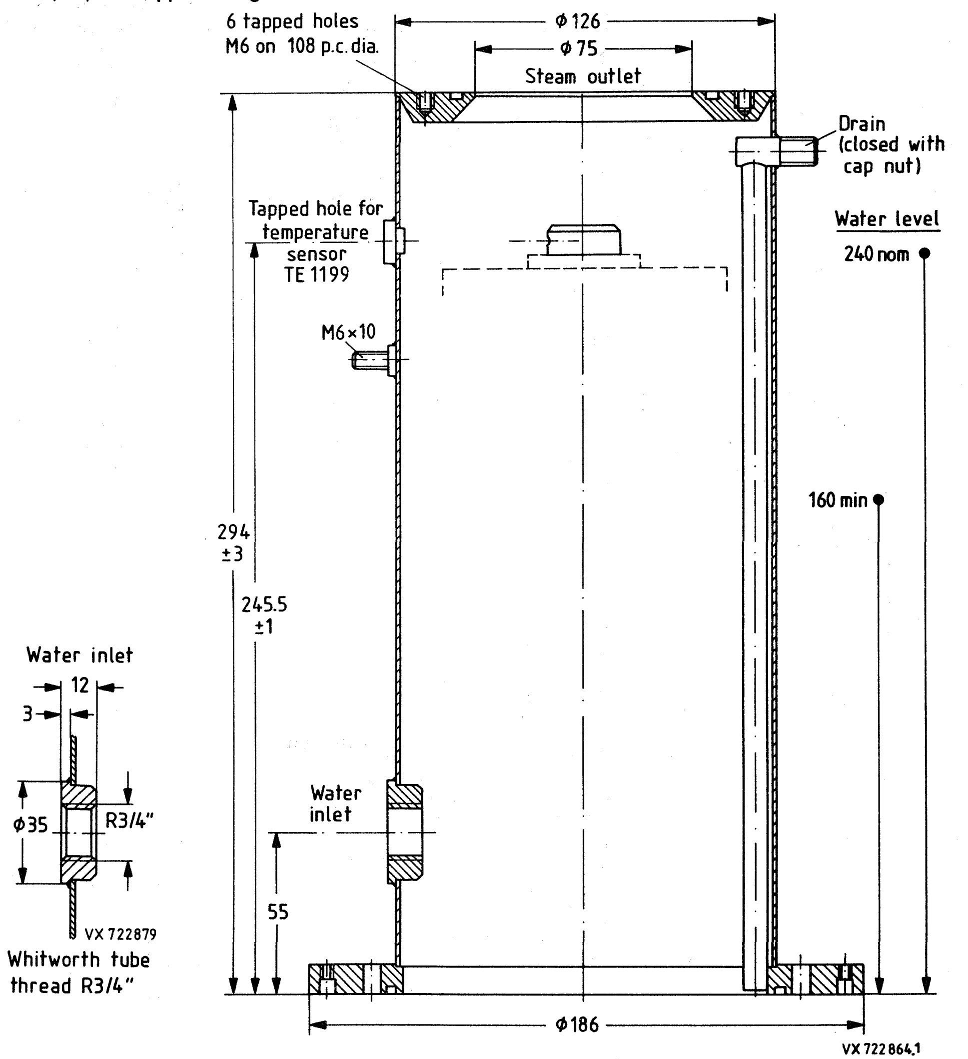
BOILER
FOR VAPOUR COOLING

for YK1220/21/23

MECHANICAL DATA

Dimensions in mm

Mass (net) approx. 5 kg



Sealing rings, bolts, temperature sensor contact block, etc. supplied with boiler.

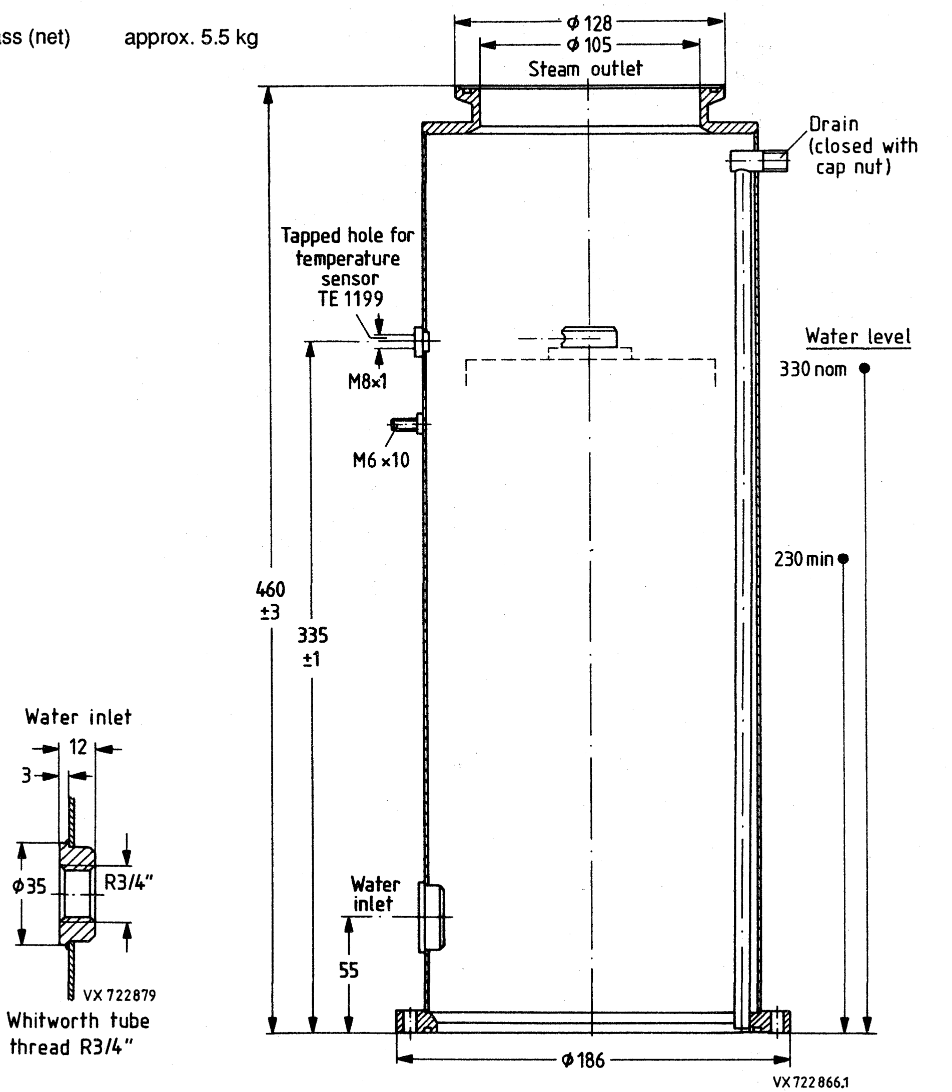
BOILER
FOR VAPOUR COOLING

for YK1230/33/34/35

MECHANICAL DATA

Dimensions in mm

Mass (net) approx. 5.5 kg

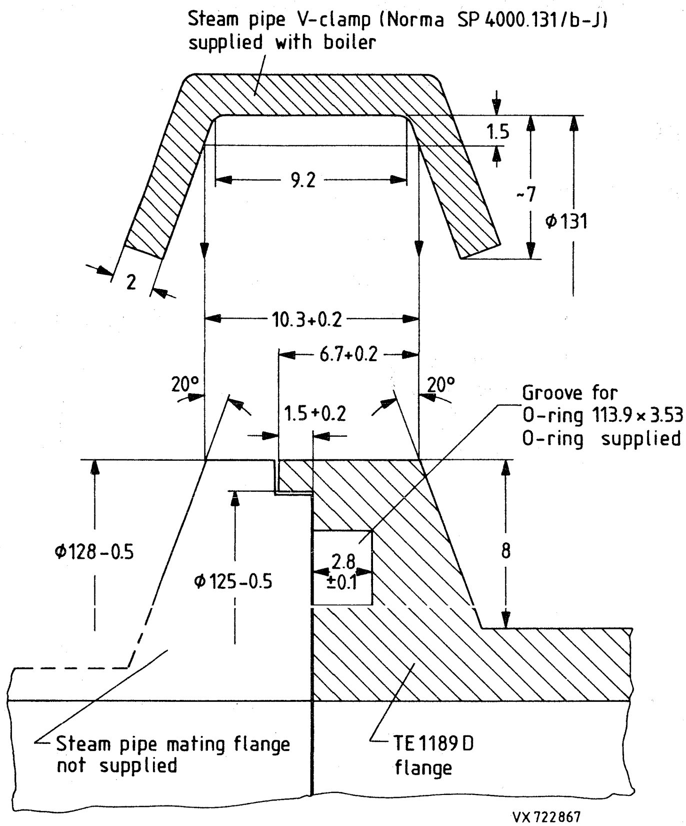


Sealing rings, bolts, temperature sensor contact block, etc. supplied with boiler.

MECHANICAL DATA

Outlines

Dimensions in mm



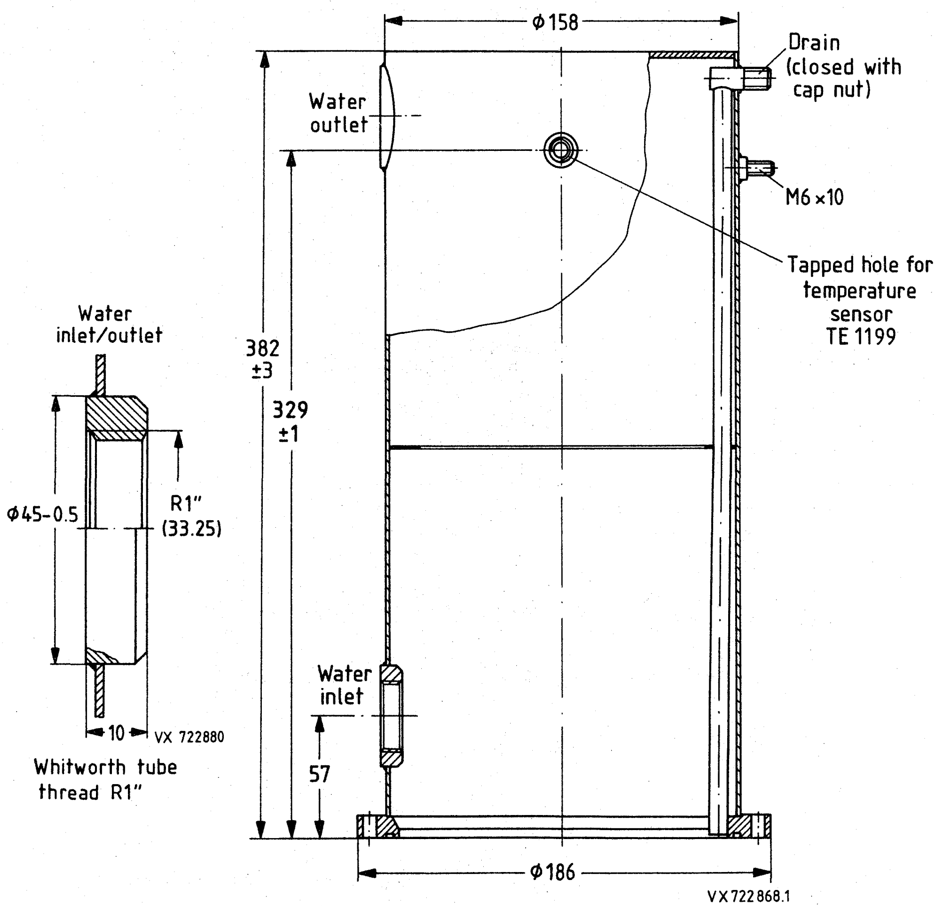
COLLECTOR COOLING JACKET
FOR WATER OR VAPOUR CONDENSATION COOLING

for YK1230/33/34/35

MECHANICAL DATA

Dimensions in mm

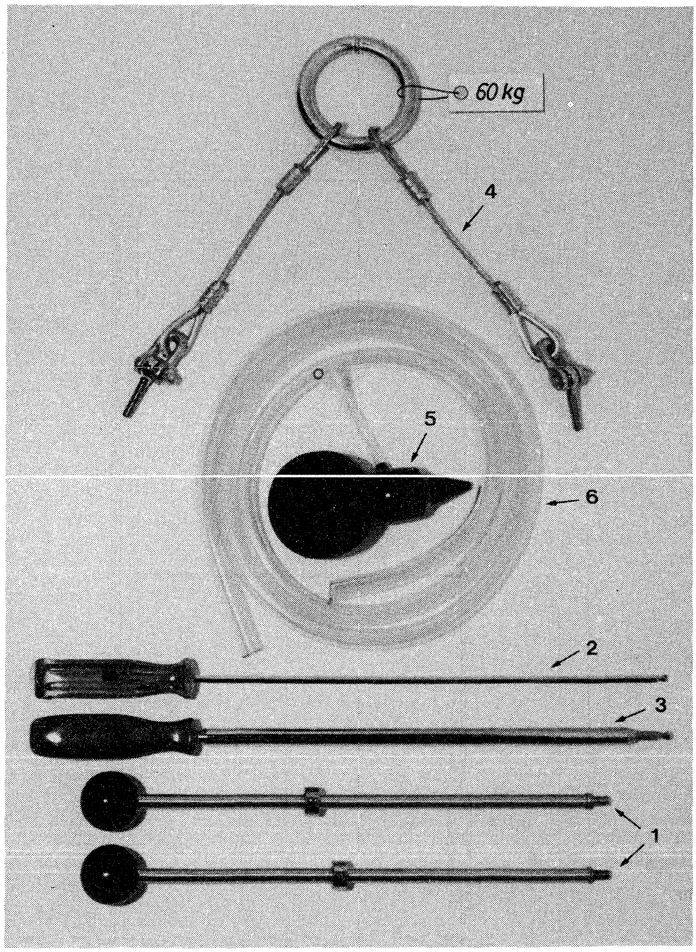
Mass (net) approx. 4.5 kg



Sealing rings, bolts, etc. supplied with collector cooling jacket.

TOOL SET

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1185, TE1185T, TE1224



1 Pair of tuning rods.

2 Allen screwdriver, 4 mm.

3 Allen screwdriver, 5 mm (non-magnetic).

4 Lifting tackle, certified load 60 kg. *

5 Syphon.

6 Plastic hose, length 1.5 m.

* Not to be used for lifting klystron types YK1263/65/67, YK1270/73

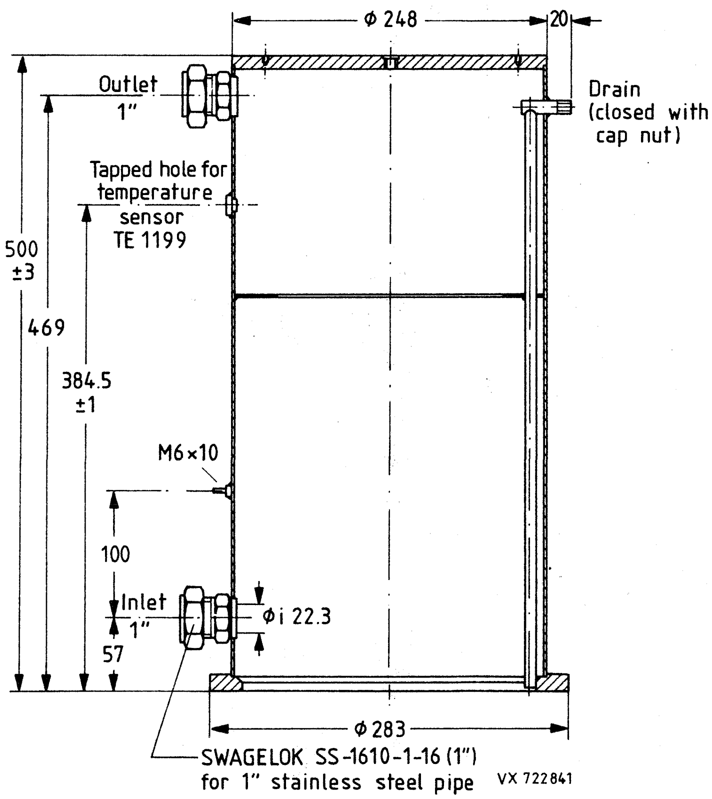
COLLECTOR COOLING JACKET
FOR WATER OR VAPOUR CONDENSATION COOLING

for YK1263/65/67

MECHANICAL DATA

Dimensions in mm

Mass (net) approx. 10.5 kg



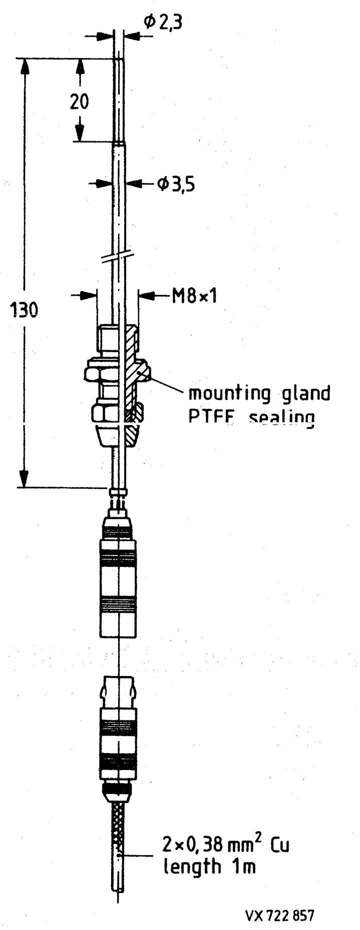
Sealing rings, bolts, etc. supplied with collector cooling jacket.

TEMPERATURE SENSOR PT-100

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67
used with TE1110H, TE1189A to G, TE1194B

MECHANICAL DATA

Dimensions in mm

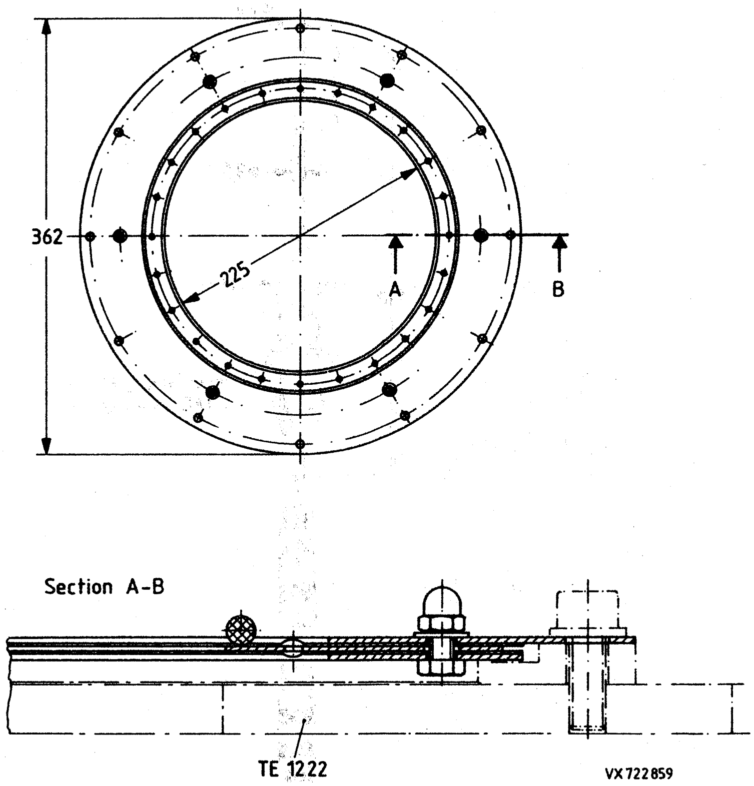


COLLECTOR RADIATION SUPPRESSOR

for YK1263/65/67

MECHANICAL DATA

Dimensions in mm



Factory mounted on magnet frame TE1222.

MAGNET FRAME WITH COILS

for YK1263/65/67

MASS AND DIMENSIONS

TE1222 in wooden box, mounted on pallet

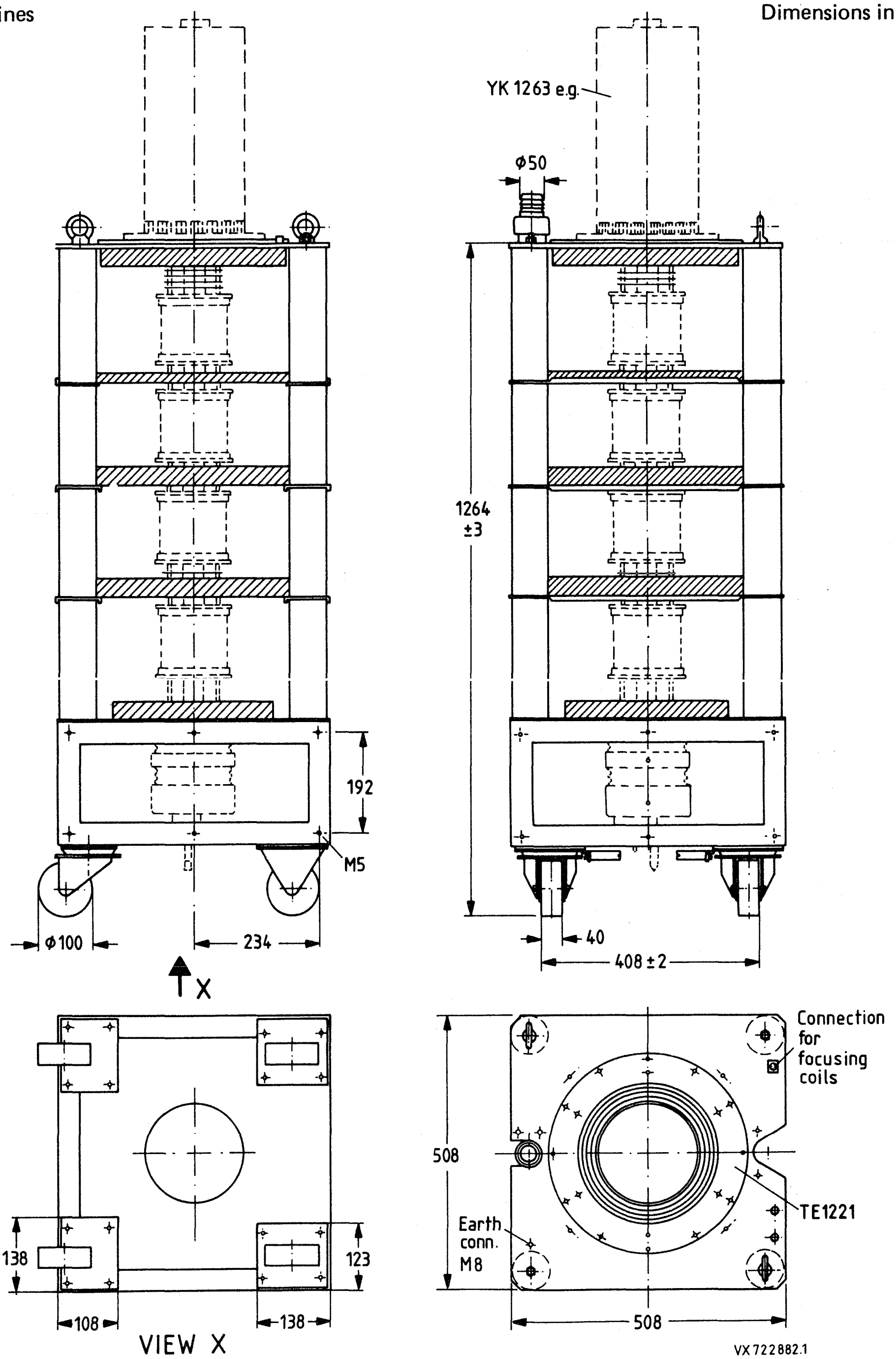
net	approx. 255	kg
gross	approx. 370	kg
outline dimensions of packing (mm)	1200 x 800 x 1540	

Outlines see next page

MECHANICAL DATA

Outlines

Dimensions in mm

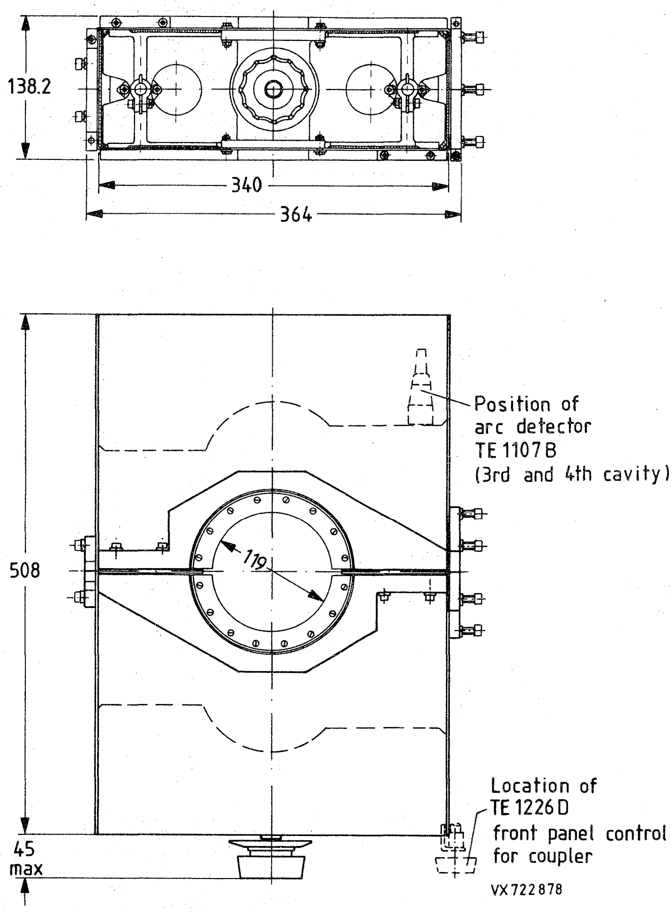


CAVITY

for YK1263/65/67

MECHANICAL DATA

Dimensions in mm



MASS AND DIMENSIONS

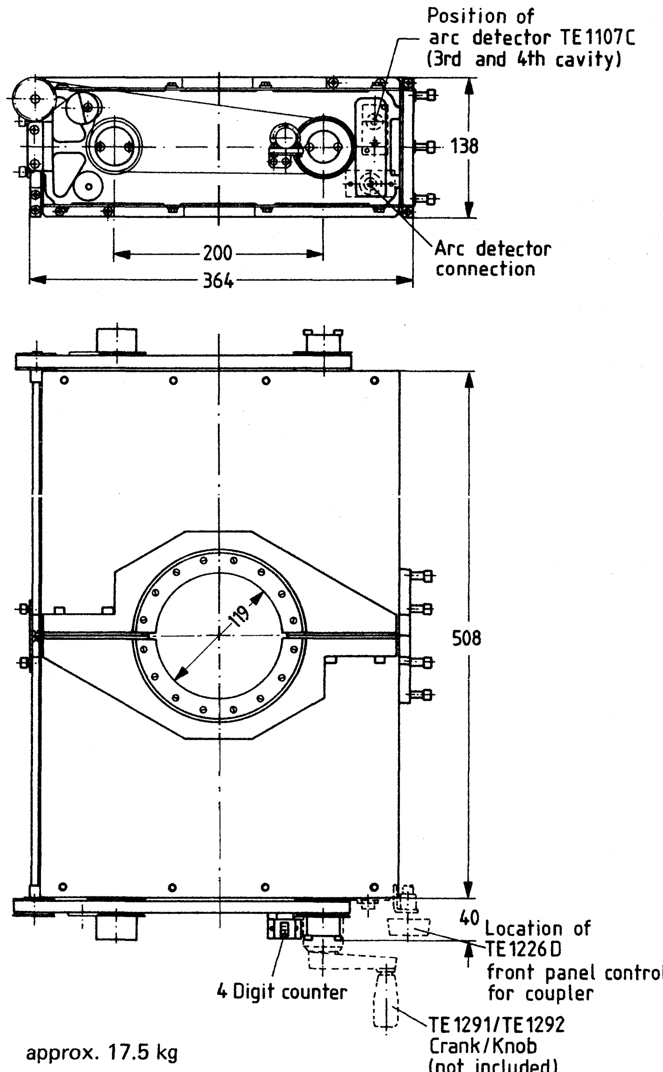
net	approx. 15 kg
gross	approx. 18.5 kg
outline dimensions of packing (mm)	680 x 520 x 250

CAVITY
CONTINUOUSLY TUNABLE

for YK1263/65/67

MECHANICAL DATA

Dimensions in mm



MASS AND DIMENSIONS

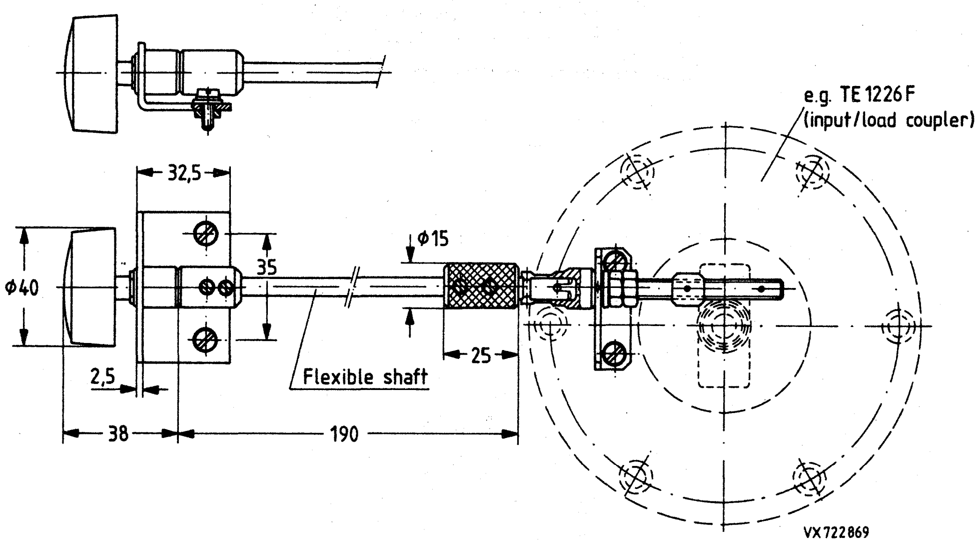
net	approx. 17.5 kg
gross	approx. 21 kg
outline dimensions of packing (mm)	680 x 520 x 250

FRONT PANEL DRIVE

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
to be used with input and load couplers TE1186F, TE1226F

MECHANICAL DATA

Dimensions in mm

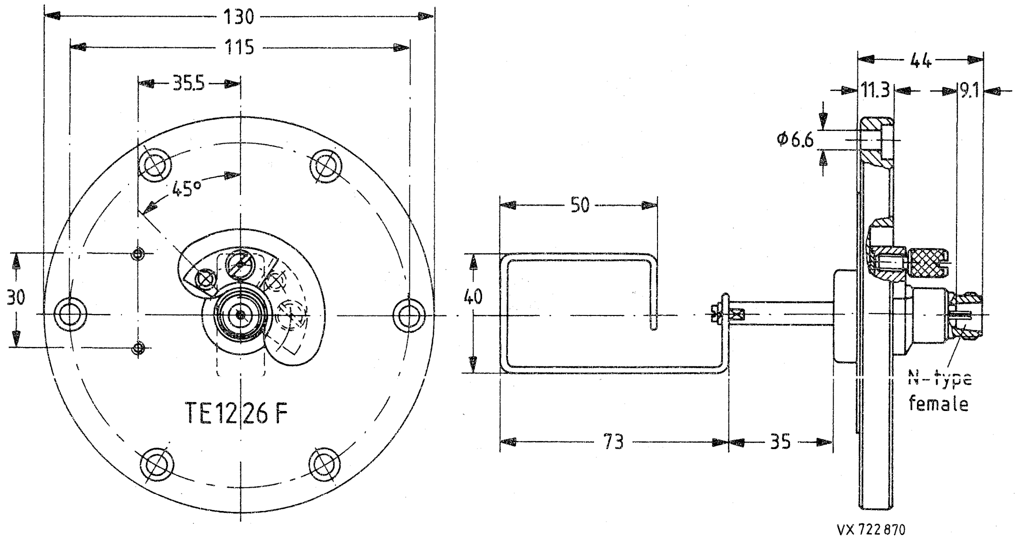


INPUT AND LOAD COUPLER FOR DIRECT CONTROL

for YK1263/65/67
used with cavities TE1224, TE1225

MECHANICAL DATA

Dimensions in mm



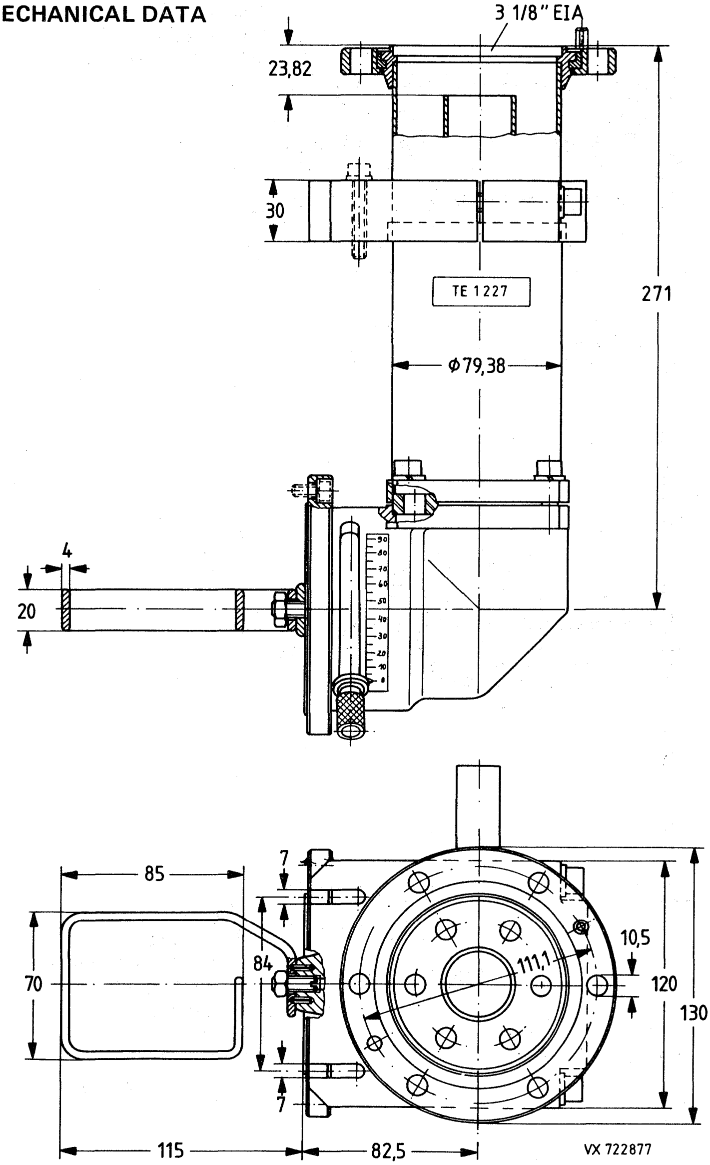
For front panel control TE1226D is additionally needed.

OUTPUT COUPLER 3 1/8" FOR DIRECT CONTROL

for YK1263/65/67
used with cavities TE1224, TE1225

MECHANICAL DATA

Dimensions in mm

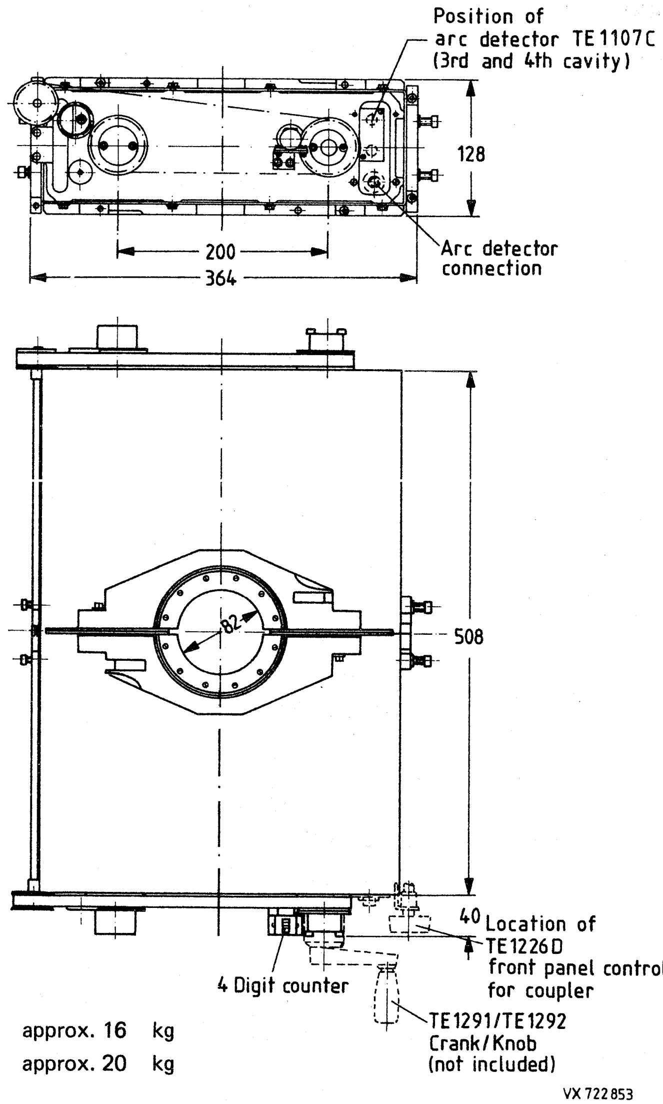


CAVITY
CONTINUOUSLY TUNABLE

for YK1220/21/23, TE1230/33/34/35, TE1270/73

MECHANICAL DATA

Dimensions in mm



MASS AND DIMENSIONS

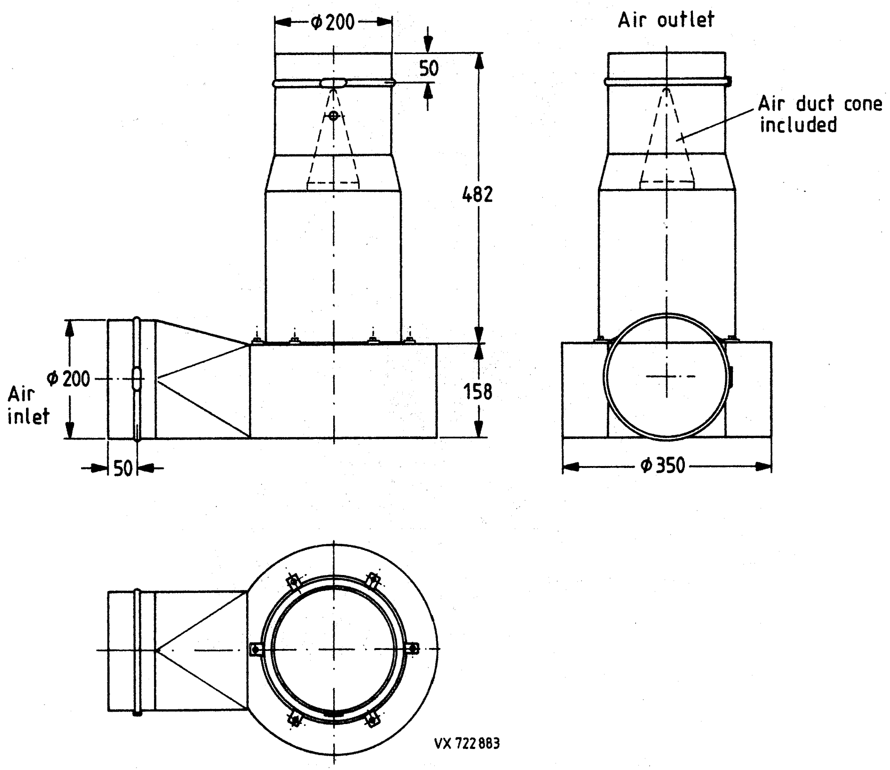
net	approx. 16	kg
gross	approx. 20	kg
outline dimensions of packing (mm)	680 x 520 x 250	

COLLECTOR COOLING AIR DUCT

for YK1270/73

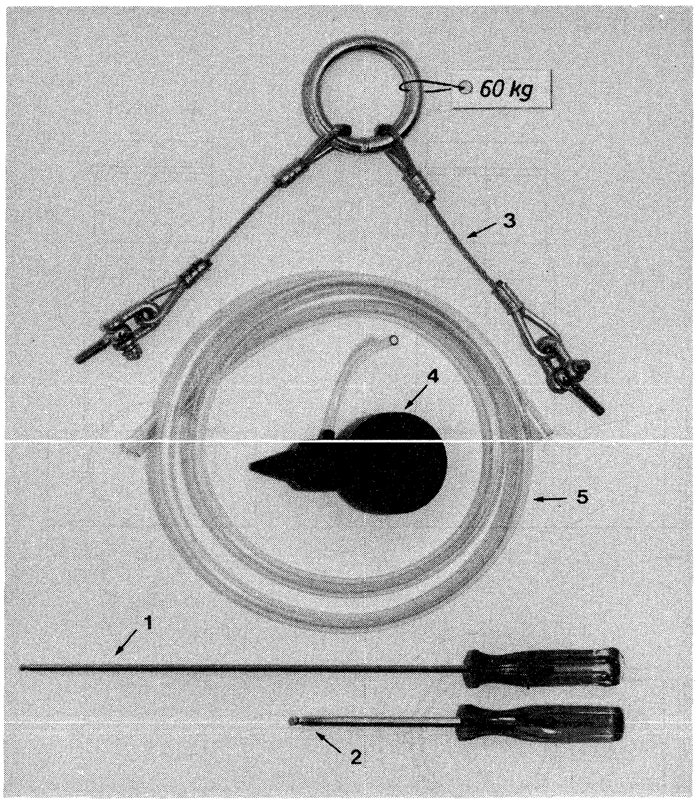
MECHANICAL DATA Dimensions in mm

Mass (net) approx. 10 kg



TOOL SET

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1225, TE1285



1 Allen screwdriver, 4 mm.

2 Allen screwdriver, 5 mm.

3 Lifting tackle, certified load 60 kg. *

4 Syphon.

5 Plastic hose, length 1.5 m.

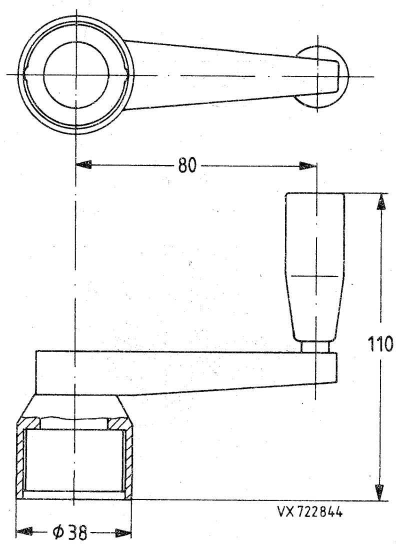
* Not to be used for lifting klystron types YK1263/65/67, YK1270/73

TUNING CRANK

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1225, TE1285

MECHANICAL DATA

Dimensions in mm

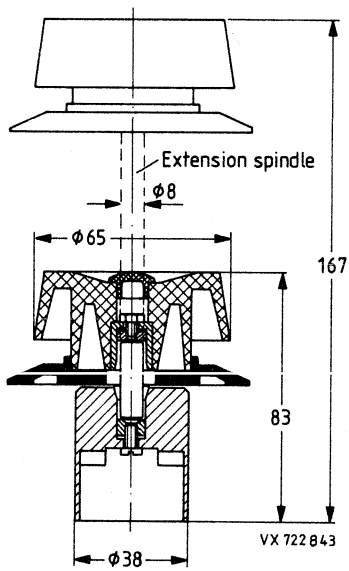


TUNING KNOB

for YK1220/21/23, YK1230/33/34/35, YK1263/65/67, YK1270/73
used with cavities TE1225, TE1285

MECHANICAL DATA

Dimensions in mm



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DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of six series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MATERIALS*

The contents of each series are listed on pages iii to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
IC08	**ECL 10K and 100K logic families**
IC09N	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** NMOS, CMOS
IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
IC17	**ICs for Telecom** Bipolar, MOS Radio pagers Mobile telephones ISDN
IC18	**Microprocessors and peripherals**
IC19	**Data communication products**

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This series of data handbooks comprises:

current code	new code	handbook title
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S2a	**SC02**	**Power diodes**
S2b	**SC03***	**Thyristors and triacs**
S3	**SC04**	**Small-signal transistors**
S4a	**SC05**	**Low-frequency power transistors and hybrid IC power modules**
S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08** **SC09**	**RF power transistors** **RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8a	**SC11***	**Light emitting diodes**
S8b	**SC12**	**Optocouplers**
S9	**SC13***	**PowerMOS transistors**
S10	**SC14**	**Wideband transistors and wideband hybrid IC modules**
S11	**SC15**	**Microwave transistors**
S15**	**SC16**	**Laser diodes**
S13	**SC17**	**Semiconductor sensors**
S14	**SC18***	**Liquid crystal displays and driver ICs for LCDs**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
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T16	**DC02**	**Monochrome monitor tubes and deflection units**
C2	**DC03**	**Television tuners, coaxial aerial input assemblies**
C3	**DC04***	**Loudspeakers**
C20	**DC05**	**Flyback transformers, mains transformers and general-purpose FXC assemblies**

* These handbooks are currently issued in another series; they are not yet issued in the Display Components series of handbooks.

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02**	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06***	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
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T2a	*****	**Transmitting tubes for communications, glass types**
T2b	*****	**Transmitting tubes for communications, ceramic types**
T3	**PC01**	**High-power klystrons and accessories**
T4	*****	**Magnetrons for microwave heating**
T5	**PC02****	**Cathode-ray tubes**
T6	**PC03****	**Geiger-Müller tubes**
T9	**PC04****	**Photo and electron multipliers**
T10	**PC05**	**Plumbicon camera tubes and accessories**
T11	**PC06**	**Circulators and Isolators**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09****	**Dry reed switches**
C8	**PC10**	**Variable mains transformers; annular fixed transformers**
	PC11	**Solid state image sensors and peripheral integrated circuits**

* These handbooks will not be reissued.
** Not yet issued with the new code in this series of handbooks.

MATERIALS

This series of data handbooks comprises:

current code	new code	handbook title
C4 **C5**	**MA01***	**Soft Ferrites**
C16	**MA02****	**Permanent magnet materials**
C19	**MA03****	**Piezoelectric ceramics**

* Handbooks C4 and C5 will be reissued as one handbook having the new code MA01.

** Not yet issued with the new code in this series of handbooks.

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