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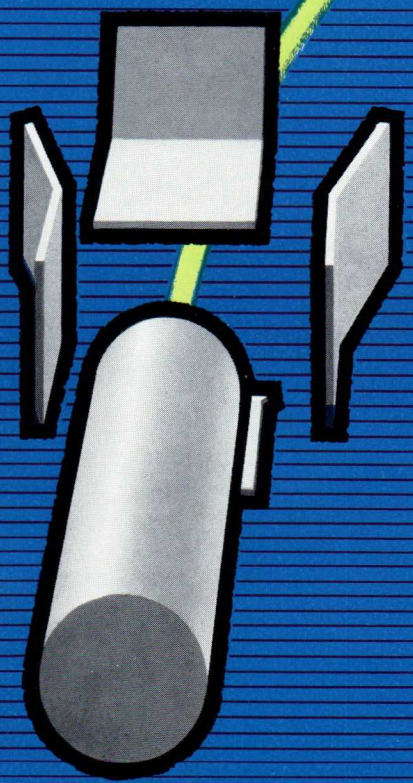
# instrument cathode-ray tubes for measuring equipment



PHILIPS ELECTRON TUBE DIVISION

# CATHODE-RAY TUBES FOR MEASURING EQUIPMENT

The extent to which electronics has penetrated into the various branches of industry and science, finds its reflection in the ever increasing number of applications in which electronic equipment is being used. Along with this development there is a tendency for the demands made on electronic equipment to grow more and more stringent. One of the fields in which this trend makes itself strongly felt is that of the cathode-ray tubes.

To enable the setmaker to keep up with the present-day developments, and to get a survey of the available tubes and their characteristics, we have listed in this folder the abridged data of a number of selected cathode-ray tubes, from which a correct choice for a given application can be made.

The following sections contain an exposition of the new techniques that have been evolved by our laboratories to ensure that each individual tube is up to the high standards required.

**Post-deflection acceleration**

In modern types of tube post-deflection acceleration is effected by means of a high-resistance electrode that is applied helically on the inside of the envelope. This method ensures a gradual rise of the post-deflection potential, and results in a considerable increase of the ratio of acceleration to post-acceleration voltage, as compared with the conventional method of single-step post-acceleration. In this way a combination of high light output and high deflection sensitivity has been reached.

**Elimination of distortion; control of astigmatism**

From the tube data it can be seen that the pattern distortion tolerances, e.g. for type D 13-21 . . are very narrow: the maximum deviation from a horizontal line is only 1.25% and the deviation from a vertical line only 0.6%. This has been achieved mainly by the very close tolerances on the deflection system components and the extremely careful assembly of it. Apart from this, means have been provided to control the geometry also electrically, in that the isolation shield inserted between the two pairs of deflection plates has been connected to a separate pin. By varying the potential of this shield, it is possible to control "pin-cushion" or "barrel" pattern distortion. In addition, the separation of the accelerator electrode and the isolation shield allows a variation of the voltage at the acceleration electrode (which may be necessary to control astigmatism), without the deflection sensitivity being influenced. Since furthermore in various types the grids No. 2 and No. 4 have been separated, the astigmatism control will not affect the brightness setting either.

**Metal-backed screens: side contacts; H-phosphor**

A great technical achievement is the realisation of a metal backing, the "cross-over" point of which lies at approx. 2.5 kV. This means that at 2.5 kV there is no difference in brightness between a metal-backed tube and a tube without metal-backing, but at 4 kV and 5 kV there will be a considerable difference in brightness. The first tube in our range with this extra feature is the D 13-15 . . Other tubes with normal metal-backing are D. 13-10, D 13-20 BE, D. 13-78 and D 13-21 . .
The recently developed H-phosphor, which improves the brightness of the screen still further, as well as the presence of side contacts render the tubes mentioned in this section particularly suitable for high-frequency applications.

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Apart from these general remarks, a few tube types will be discussed individually.

**D. 7-78**

This type has a so-called decelerating lens. The grids No. 2 and No. 4 have been brought out separately so that at the same time a relatively high voltage can be applied to grid No. 2, which ensures good spot quality and ample screen current, and a low voltage to grid No. 4, resulting in a high sensitivity.

**D. 7-11**

This is the first type in our range that is intended for transistorised oscilloscopes (up to frequencies of 5 to 10 Mc/s). Apart from its low heater consumption (0.6 W) the D. 7-11 is electrically and mechanically identical to type D. 7-78.

**D.M 9-11**

The D.M 9-11 is the first dual-gun type in our programme. It is provided with completely separated guns for the two electron beams. The tube is intended for medium-class oscilloscopes.

**D.M 10-93**

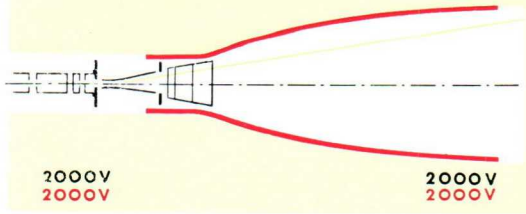
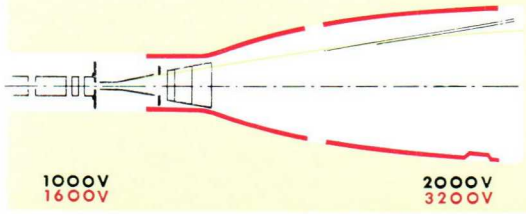
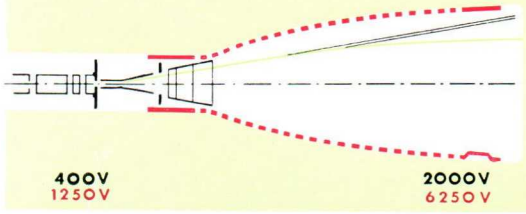
This tube is of the "split-beam" type, and has two independent vertical deflection systems. Since the deflection system for the timebase is common, spot deflection in horizontal direction is identical for two vertical signals, which is of great use in those applications where a relation between two phenomena must be determined. The D.M 10-93 permits the design of an inexpensive dual-trace oscilloscope.

**D 13-20 BE**

For applications in which it is required to photograph extremely high writing speeds, the voltages applied to this tube may be raised to 4/24 kV.

For inexpensive and compact measuring equipment our well-known range of 7-cm indicator tubes still finds wide application, thanks to their favourable properties, such as small dimensions, good sensitivity and spot quality, and low anode voltage.

To conclude this survey, a special type of cathode-ray tube is mentioned, the D. 3-91, which was designed for indicating and monitoring purposes in all kinds of electronic equipment. Its anode voltage has been kept low, so that a very simple power supply unit suffices. Another advantage of the tube is its automatic focus control.

| | | SENSITIVITY V/cm | BRIGHTNESS (mcd/cm²) |
|---|---|---|---|
| Fig. 1 |   | N N | B B |
| Fig. 2 |   | $\frac{1}{1.6}$ N N | B 1.6 B |
| Fig. 3 |   | $\frac{1}{3.1}$ N N | B 3.1 B |

## PRINCIPLE OF POST-DEFLECTION ACCELERATION

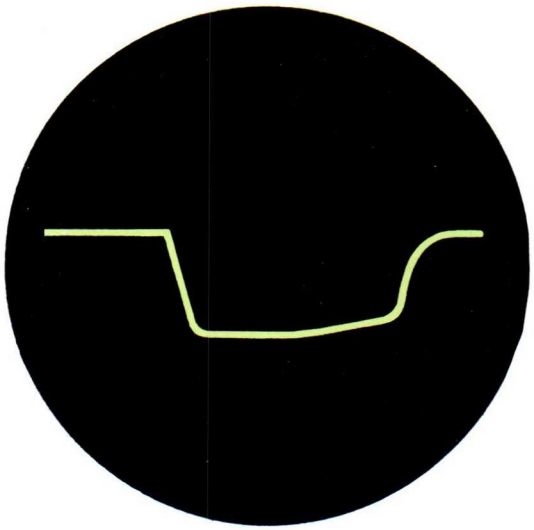
To evaluate the influence of the various post acceleration methods the following systems are compared:

(a) tube without post acceleration (Fig. 1);

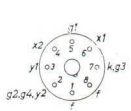
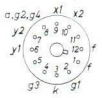
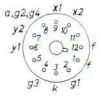
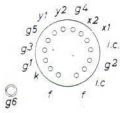
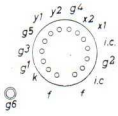
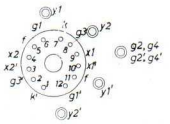
(b) tube with conventional one-step post acceleration; the ratio of post-acceleration voltage to acceleration voltage is max. 2 (Fig. 2);

(c) tube with modern helical post-acceleration electrode (in the example given in Fig. 3 the ratio of post-acceleration voltage to acceleration voltage is 5).

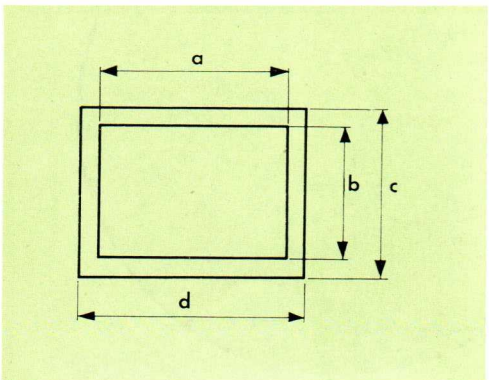
It can be seen from the figures that, when the voltages are adjusted for a given brightness B, the application of post acceleration results in an increased sensitivity N. Notably a helical post-acceleration electrode shows a considerable improvement in this respect. Conversely, in the same instances the brightness will be appreciably increased when the sensitivity is kept constant.



| | D. 3-91 | D. 7-31 | D. 7-32 | D. 7-11 | D. 7-78 | D.M 9-11 |
|---|---|---|---|---|---|---|
| acceleration voltage (maximum) | 1000 | 800 | 800 | 2100 | 2100 | 1800 |
| post acceleration voltage (maximum) | | | | 5000 | 5000 | |
| acceleration voltage (typical) | 500 | 500 | 500 | 1200/300 | 1200/300 | 1500 |
| post acceleration voltage (typical) | | | | 1200 | 1200 | |
| ratio of post deflection acceleration voltage to acceleration voltage (typical) | | | | 4 | 4 | |
| deflection factor $M_y$ (vertical) [1] | 45 | 21 | 21 | 3.65 | 3.65 | 16 |
| deflection factor $M_x$ (horizontal) [1] | 53 | 37 | 37 | 10.7 | 10.7 | 23 |
| vertical scan [1] | full | full | full | 45 | 45 | full |
| horizontal scan [1] | full | full | full | 60 | 60 | full |
| line width [1] | 0.6 | 0.5 [2] | 0.5 [2] | 0.65 [8] | 0.65 [8] | 0.4 [8] |
| heater voltage | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| heater current | 550 | 300 | 300 | 90 | 300 | 1250 |
| pattern distortion [3] (see below) | | | | | | |
| maximum length | 105 | 172 | 172 | 285 | 285 | 310 |
| symmetric/asymmetric deflection | asymmetric [7] | asymmetric | asymmetric | symmetric | symmetric | symmetric |
| tube holder — base | English loctal 8 p. | duodecal 12 p. | duodecal 12 p. | all-glass 14 p. | all-glass 14 p. | B 12 F |
| tube holder — holder | 5902/20 [4] 40213 [5] | 5912/20 [4] | 5912/20 [4] | 40467 | 40467 | 55562 [5] |
| tube holder — mounting ring | | | | | | |
| mu-metal screen | 55525 | 55530 | 55530 | 55532 | 55532 | 55544 |
| post deflection acceleration connector | | | | 55563 | 55563 | 55560 |
| side contacts | | | | | | |
| available screen versions | H | G | G | B, H, N, P | B, H, N, P | H |

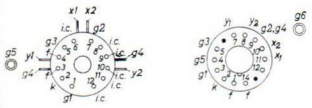







## Pattern distortion limits




| type | a | b | c | d |
|---|---|---|---|---|
| D. 7-31/7-32 | 40 | 40 | 43.2 | 43.2 |
| D. 7-11/7-78 | 39.2 | 39.2 | 40.8 | 40.8 |
| D.M 9-11 | 48.75 | 48.75 | 51.25 | 51.25 |
| D.M 10-93 | 57 | 57 | 60 | 60 |
| D. 10-78 | 49 | 49 | 51 | 51 |

| D.M 10-93 | D. 10-78 | units |
|---|---|---|
| 4000 | 2100 | V |
| 8000 | 8000 | V |
| 1500 | 1000 | V |
| 3000 | 4000 | V |
| 2 | 4 | |
| 27 | 10.8 | V/cm |
| 27 | 34 | V/cm |
| 70 [6]) | 55 | mm |
| 90 | 75 | mm |
| 0.2 [8]) | 0.35 [8]) | mm |
| 6.3 | 6.3 | V |
| 550 | 300 | mA |
| | | |
| 393 | 305 | mm |
| asymmetric [7]) | symmetric | |
| B 12 F | diheptal 12 p. | |
| 55562 [5]) | 5914/20 [4]) | |
| | 40638 | |
| 55542 | 55541 | |
| 55563 | 55560 | |
| 55561 | | |
| H | B, H, N, P | |



1 measured under typical operating conditions

2 measured on a circle of 35 mm diameter, with 0.5 $\mu$A screen current

3 under typical operating conditions, if possible optimally adjusted for astigmatism, barrel-pattern or pin-cushion distortion, a nominally rectangular raster may be inserted into the frame bounded by concentric rectangles, the dimensions of which are given in the columns

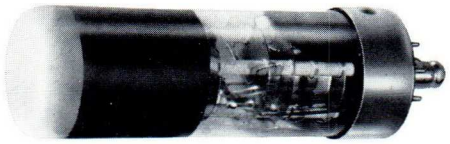
4 synthetic resin

5 ceramic

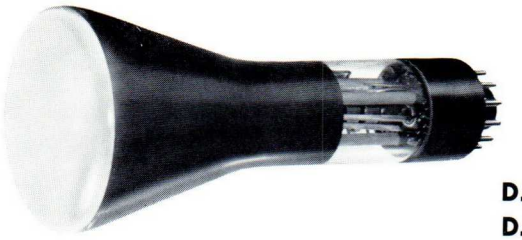
6 for each vertical deflection system the useful scan is min. 70 mm; the overlap of the two scans is max. 50 mm

7 in vertical direction

8 shrinking raster method, screen current 10 $\mu$A



D. 3-91

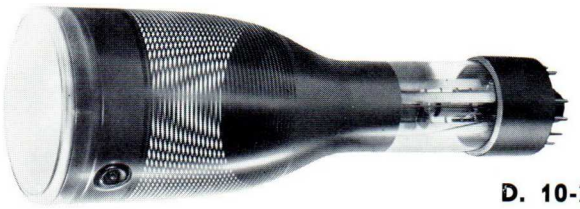


D. 7-31
D. 7-32

D. 7-11
D. 7-78

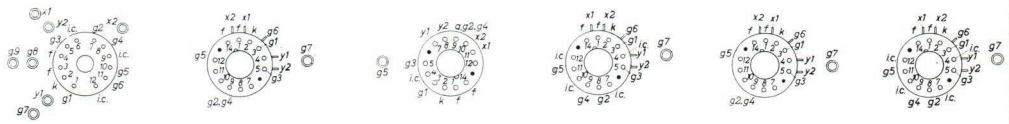
D.M 9-11

D.M 10-93

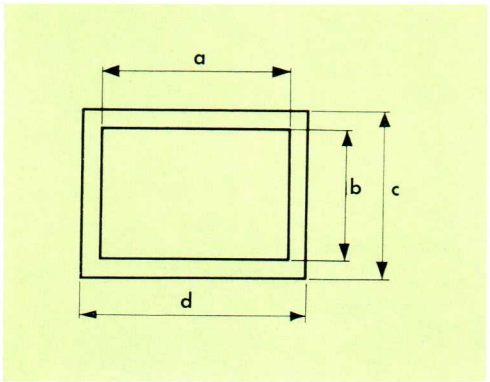


D. 10-78

| | D. 13-10 | D 13-20 BE | D. 13-34 | D 13-15 . . | D. 13-78 | D 13-21 . . |
|---|---|---|---|---|---|---|
| acceleration voltage (maximum) | 3300 | 4000 | 2600 | 2200 | 2200 | 2200 |
| post acceleration voltage (maximum) | 17300 | 24000 | 6000 | 6000 | 12000 | 12000 |
| acceleration voltage (typical) | 1500 | 4000 | 1500 | 2000 | 1670 | 1670 |
| post acceleration voltage (typical) | 15000 | 24000 | 3000 | 4000 | 10000 | 10000 |
| ratio of post deflection acceleration voltage to acceleration voltage (typical) | 10 | 6 | 2.3 | 2 | 6 | 6 |
| deflection factor $M_y$ (vertical) [1] | 2.7 | 16 | 13.2 | 5.9 | 6.45 | 6.45 |
| deflection factor $M_x$ (horizontal) [1] | 11.2 | 74.5 | 23.6 | 22 | 30 | 30 |
| vertical scan [1] | 60 | 40 | 100 | 60 | 40 | 40 |
| horizontal scan [1] | 100 | 100 | 100 | 100 | 100 | 100 |
| line width [1] | 0.6 [2] | 0.2 [6] | 0.3 [6] | 0.5 [6] | 0.6 [2] 0.4 [6] | 0.6 [2] 0.4 [6] |
| heater voltage | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| heater current | 550 | 300 | 600 | 300 | 300 | 300 |
| pattern distortion [3] (see below) | | | | | | |
| maximum length | 508 | 468 | 430 | 468 | 468 | 168 |
| symmetric/asymmetric deflection | symmetric | symmetric | symmetric | symmetric | symmetric | symmetric |
| tube holder — base | B 12 F | diheptal 12 p. | diheptal 12 p. | diheptal 12 p. | diheptal 12 p. | diheptal 12 p. |
| tube holder — holder | 55562 [5] | 5914/20 [4] | 5914/20 [4] | 5914/20 [4] | 5914/20 [4] | 5914/20 [4] |
| tube holder — mounting ring | | 40638 | 40638 | 40638 | 40638 | 40638 |
| mu-metal screen | 55552 | 55551 | 55550 | 55551 | 55551 | 55551 |
| post deflection acceleration connector | 55563 | 55563 | 55560 | 55563 | 55563 | 55563 |
| side contacts | 55563 | 55561 | | 55561 | 55561 | 55561 |
| available screen versions | H, N | BE | B, G, P | BE, GH, GL | B, H, N, P | BE, GH, GL, GM |

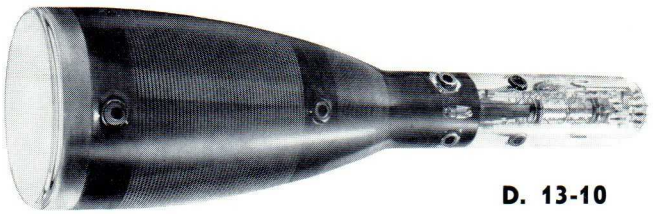


## Pattern distortion limits



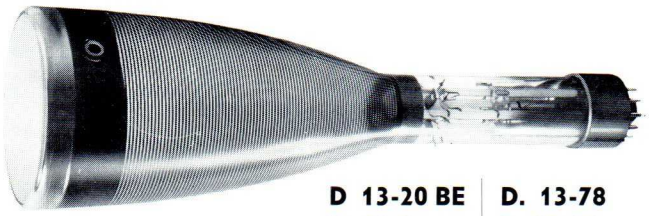

| type | a | b | c | d |
|---|---|---|---|---|
| D. 13-10 | 78.4 | 49 | 51 | 81.6 |
| D 13-20 BE | 78 | 39 | 40 | 80 |
| D. 13-34 | 78.4 | 78.4 | 81.6 | 81.6 |
| D 13-15 . . | 98 | 58.5 | 60 | 100 |
| D. 13-78 | 98 | 38.8 | 40 | 100 |
| D 13-21 . . | 98.8 | 39 | 40 | 100 |

| D. 16-22 | units |
|---|---|
| 6000 | V |
| | V |
| 5000 | V |
| | V |
| | |
| 47.5 | V/cm |
| 52.5 | V/cm |
| full | mm |
| full | mm |
| | mm |
| 6.3 | V |
| 300 | mA |
| | |
| 430 | mm |
| symm./asymm. | |
| diheptal 14 p. | |
| 5914/20 [4]) | |
| 40638 | |
| 55559 | |
| | |
| | |
| B, G, P | |

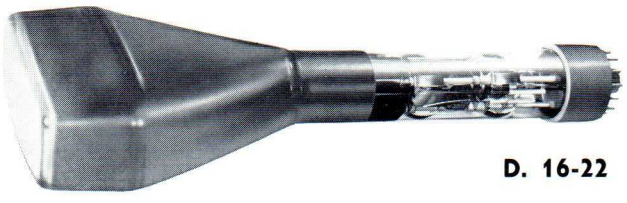


**D. 13-10**

**D. 13-34**



**D 13-20 BE** | **D. 13-78**
**D 13-15 . .** | **D 13-21 . .**



**D. 16-22**

**1** measured under typical operating conditions

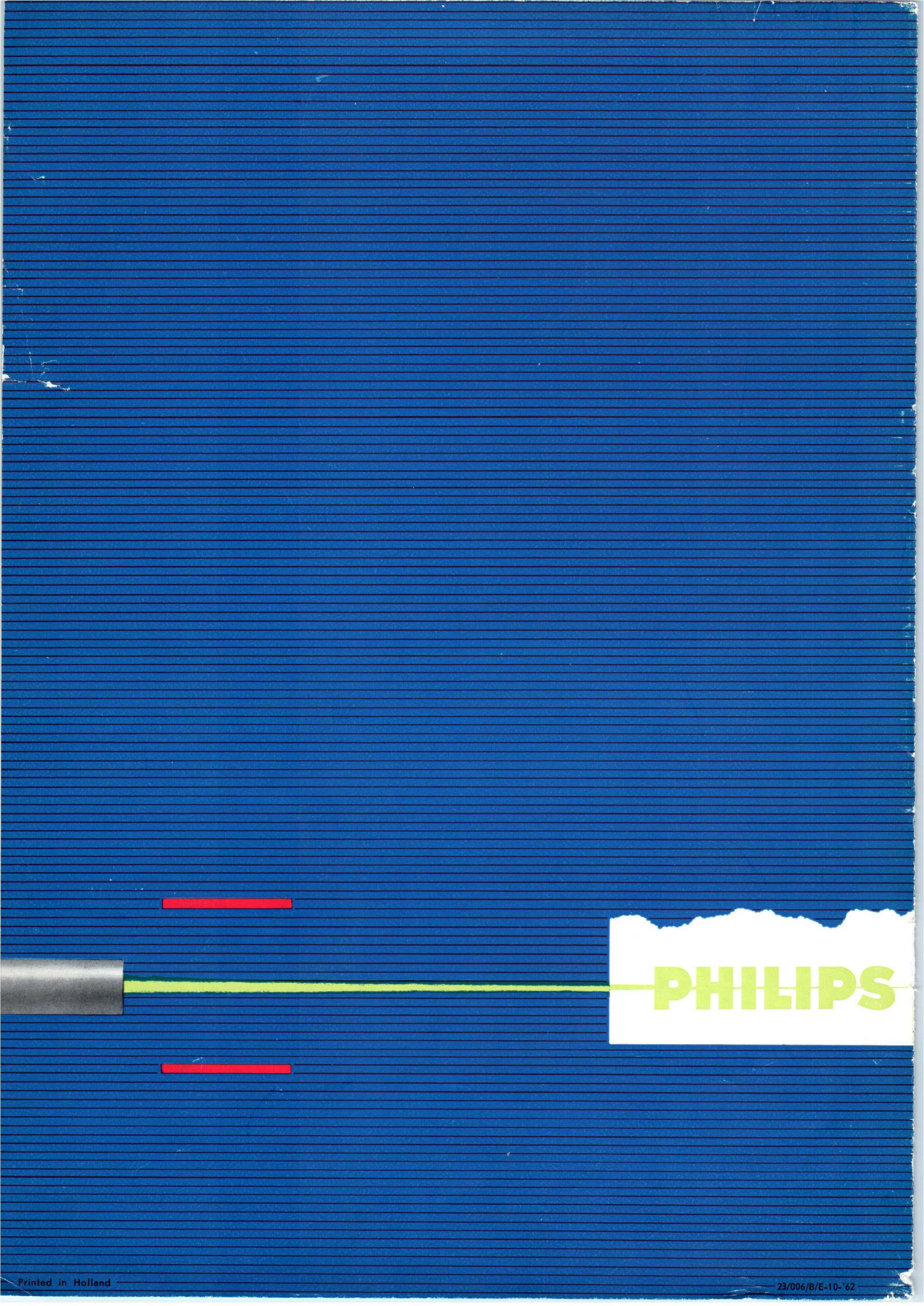
**2** shrinking raster method, screen current 25 $\mu$A

**3** under typical operating conditions, if possible optimally adjusted for astigmatism, barrel-pattern or pin-cushion distortion, a nominally rectangular raster may be inserted into the frame bounded by concentric rectangles, the dimensions of which are given in the columns

**4** synthetic resin

**5** ceramic

**6** shrinking raster method, screen current 10 $\mu$A

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