Jan. 2, 1962 J. C. FRANCKEN 3,015,749

HIGH TRANSCONDUCTANCE CATHODE-RAY TUBE

Filed June 11, 1959

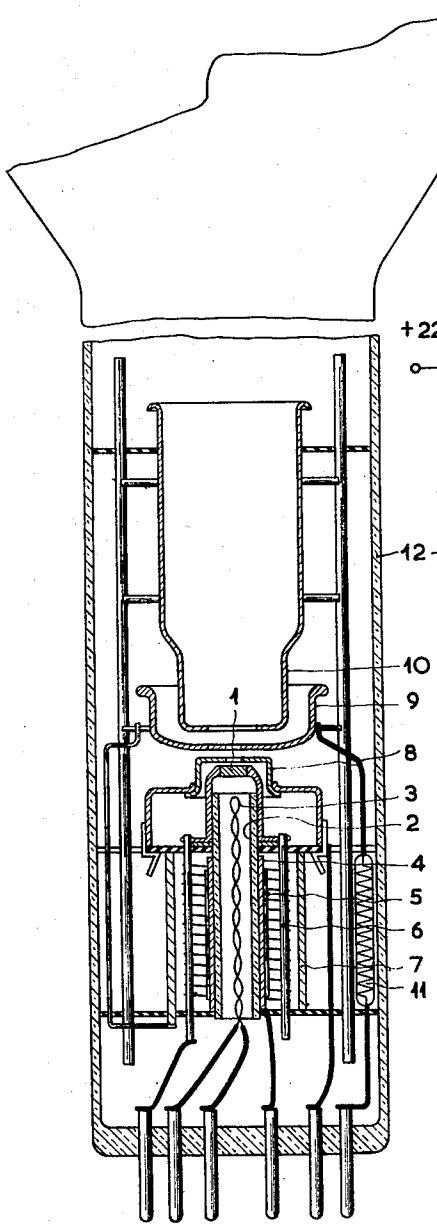


FIG. 1

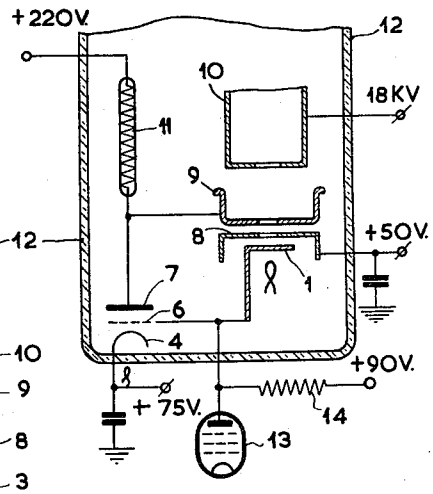


FIG. 2

INVENTOR

JAN CAREL FRANCKEN

BY

Frank R. Trifari

AGENT

United States Patent Office 3,015,749 Patented Jan. 2, 1962

3,015,749

HIGH TRANSCONDUCTANCE CATHODE-RAY TUBE

Jan Carel Francken, Eindhoven, Netherlands, assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed June 11, 1959, Ser. No. 819,659
Claims priority, application Netherlands July 17, 1958
5 Claims. (Cl. 315—3)

The present invention relates to devices comprising a cathode-ray tube, the gun of which at least comprises a cathode, a control electrode and a first anode, and in which steps have been taken for increasing the modulation curve slope or transconductance of the gun.

It is known that the slope of the modulation curve of the gun of a cathode-ray tube can be increased by applying the control voltages not only to the control electrode but also to the first anode.

This can be effected in a simple manner by applying the control voltages to the cathode since in this case the cathode potential alternates both with regard to the control electrode and with regard to the first anode. This effect is increased if the first anode has a considerable penetration effect (durchgriff) on the cathode current, since an increase in voltage on the first anode then involves an appreciable increase of the electron current and consequently contributes to the increase in current produced by the control electrode.

In practice, however, it is found that limits are set to the increase of the penetration coefficient of the first anode. As a matter of fact, this penetration coefficient may be increased by reducing the thickness of the control electrode and by diminishing the distance of the control electrode from the first anode and the cathode relatively to the opening of the control electrode. However, a limit is set to reducing the electrode spacings on account of structural difficulties, while a greater grid-opening involves a larger picture spot on the screen and consequently results in lower definition of the picture.

It is known to reduce these difficulties by supplying an amplified signal to the first anode, the control signal being amplified by an amplifier tube which is in most cases arranged outside the cathode-ray tube. This has a limitation in that the higher capacity of the circuit elements and their lead-through and junction conductors to the anode and the grid of the amplifier tube adversely affects the bandwidth of the signal by increasing the R-C time of these electrodes and the anode coupling resistance, since the required anode current of the amplifier tube should be heavy and the anode coupling resistance should be low, for example 2000 ohms, in order for the R-C time to be maintained sufficiently short with the higher capacity.

These disadvantages are accentuated if the electrodes of the gun are located very close together in order to increase the penetration coefficient of the first anode, since the capacity is also increased thereby. Hence, the amplifier tube has to carry a considerable heavy current (approximately 20 to 30 ma. anode current).

If the triode system is incorporated in the gun of a cathode-ray tube, a considerable increase of the R-C time will still occur because with known circuits, a number of circuit elements is present, which preferably should also be incorporated in the cathode-ray tube if the increase in capacities of the auxiliary amplifier is to be maintained low relative to "earth" which, in turn, involves difficulties in conjunction with the liberation of gas of these component parts, unless using expensive particular parts. Moreover, such component parts occupy much room, which is a serious limitation since the usual dimensions of

the neck of the cathode-ray tube scarcely allow of introducing the gun.

In a device comprising a cathode-ray tube of this type, in which an amplification system is incorporated in the gun, said disadvantages are avoided for the major part, if in accordance with the invention, the control grid of the amplification system is directly electrically connected to the cathode of the gun, and the anode of the amplification system is directly electrically connected to the first anode of the gun, while the "control range of the control grid" of the amplification system at maximum anode voltage (white picture) exceeds one-third of the control range of the gun at a minimum voltage of the first anode (black picture). The term "control range" is here to be understood to mean the range of the control electrode voltage between the cut-off point and the point at which the control electrode itself will collect current. The invention yields the advantage that, as the case may be, only the anode-coupling resistor of the amplification system need be housed in the neck of the cathode-ray tube and that this resistor may have a comparatively high value, since the capacities relative to "earth" can be maintained low. As a result, the amplification system has to carry only a small current (approximately 4 ma. or less). Also, it is no longer necessary highly to increase the penetration coefficient of the first anode artificially, and the control electrode and the first anode can be spaced more widely from each other, thus reducing the capacity between these electrodes. By suitably shaping the control electrode of the gun and the first anode, this capacity may attain an extremely low value. Consequently, this permits the gun to be built as advantageously as possible with a view to the desired size of the picture spot.

In a specific example, the cathode for the triode-section has a diameter of 1.8 mm. and a length of the emitting surface of 6 mms. The grid consists of turns of 60 micron wires, wound with a pitch of 0.4 mm. The cathode-grid spacing is 300 microns, and the grid to anode spacing is 350 microns. The distance between the gun cathode surface and the control electrode is 100 microns, and the distance between control electrode and first anode is 250 microns.

In order that the invention may be readily carried into effect, an example will now be described in detail with reference to the accompanying drawing, in which

FIG. 1 is a sectional view of a cathode-ray tube having a gun with incorporated amplification system, and

FIG. 2 shows schematically the circuit arrangement of a gun comprising an amplifier according to the invention.

In the drawing, the reference numeral 1 designates the cathode for producing the electron beam. The cathode 1 is secured to a ceramic tube 2 containing a heating member 3. A cathode 4 with an electron-emissive layer 5 is provided on the lower part of the ceramic tube 2, which cathode is surrounded by a grid 6 and an anode 7. The grid 6 has such a considerable pitch (400 microns) and is so located relatively to the cathode 4 and the anode 7 that the control range of the triode exceeds one-third of that the gun at the voltage value of the first anode at the instant the picture is "black." In front of the cathode 1, provision is made of a control electrode 8 for controlling the intensity of the electron beam, a first accelerating anode 9 and final anode 10. The aggregate is incorporated in a glass envelope 12 of a cathode-ray tube. As shown schematically in FIG. 2, the cathode 1 of the gun is directly connected to the grid 6 of the triode system, while the first anode 9 is directly connected to the anode 7 of the triode and, through a resistor 11, to a source of direct voltage of +220 v. The grid 6 and the cathode 1 are connected to the anode of the video-output tube 13 and are connected, through a resistor 14, to a

positive voltage of, say, 90 v. The cathode 4 of the triode is connected to a supply of +75 v. As may be seen, solely the resistor 11 need be incorporated in the vacuum space, in contrast to the aforesaid conventional arrays. This resistor may have a comparatively high value (for example 30,000 ohms), while the gun may be proportioned as advantageously as possible in the usual manner in view of the picture to be reproduced.

Hence, no undue compromise need be made for an additional increase in penetration coefficient from the first anode to the cathode. A suitable value of the penetration coefficient is, for example, 40 to 50%.

As a result of the shape of the control electrode 8 and the first anode 9 their relative capacity is very low, the more so since their relative spacing need not be minimal. As a matter of fact, this may then be 250 microns. As a result, the R-C time of the anodes 7, 9 and the resistor 11 despite the use of a resistor 11 having a comparatively high value, may be sufficiently low to maintain an adequate bandwidth. In this embodiment, the capacity is lower than the permissible maximum capacity of, say, 2 pf.

Since the construction of the triode is substantially independent of that of the gun itself, the pitch and size of the grid and of the anode may be chosen to be such that if the anode voltage is maximum (for example 150 v.), that is with a "white" signal, a large control range (approximately 20 to 30 v.) is obtained. This control range should exceed one-third of and may even be equal to that of the control electrode of the gun, which latter control range amounts to approximately 25 v. at a minimum first anode voltage (with "black" signal approximately 60 v.).

When the picture is "black," no gun current flows, which means that, with cathode injection of the video signal, the cathode is most positive and so is the control grid 6 of the amplifying triode to which it is directly connected. With the grid 6 most positive, maximum tube-current flows, which means that the plate 7, and the gun anode 9 to which it is directly connected, are at their minimum voltage value.

Although only one embodiment has been described, it will be evident that the structural design of the gun and of the triode system may, within the scope of the invention, be varied.

What is claimed is:

1. A cathode-ray tube comprising an envelope, an electron beam producing electrode system within the envelope and comprising a first cathode, a first control grid, and a first accelerating anode, an amplifying electrode system also within the envelope and comprising a second cathode, a second control grid, and a second anode, an impedance within the envelope, means directly connecting the first and second anodes together and to said impedance, means for applying to the impedance a potential, means directly connecting together the first cathode and the second control grid, and means for applying a signal potential to the connected first cathode and second control grid.

2. A tube as set forth in claim 1 wherein the impedance is a resistor, a common heating filament is provided for the first and second cathodes, the beam producing electrode system has a planar geometry, and the amplifying electrode system has a cylindrical geometry.

3. A cathode-ray device comprising an envelope, an electron beam producing electrode system within the envelope and comprising a first cathode, a first control grid, and a first accelerating anode, an amplifying electrode system also within the envelope and comprising a second cathode, a second control grid, and a second anode, an impedance, means directly connecting together the first and second anodes and coupling said direct connection to said impedance, means for applying to the directly connected anodes through the impedance a potential, whereby the voltages appearing directly at the anode electrodes vary between minimum and maximum values as a function of the current flow through the amplifying electrode system, and means directly connecting together the first cathode and the second control grid, said amplifying electrode system having a control grid voltage range, between that value of control grid voltage at which current through the electrode system is cut-off and that value at which current flows to the control grid, at the maximum second anode voltage greater than one-third of the corresponding control grid voltage range of the beam producing electrode system at the minimum first anode voltage.

4. A device as set forth in claim 3 wherein means are provided for coupling a signal voltage to the directly-coupled first cathode and second control grid.

5. A device as set forth in claim 3 wherein the impedance is a resistor having a high value of resistance, and the second control grid comprises a winding having a large pitch.

References Cited in the file of this patent

UNITED STATES PATENTS

2,163,210	Wienecke	June 20, 1939
2,173,498	Schlesinger	Sept. 19, 1939

FOREIGN PATENTS

1,089,337	France	Sept. 29, 1954