

Dec. 31, 1940.

K. SCHLESINGER

2,226,991

TELEVISION TUBE

Filed Nov. 21, 1934

2 Sheets-Sheet 1

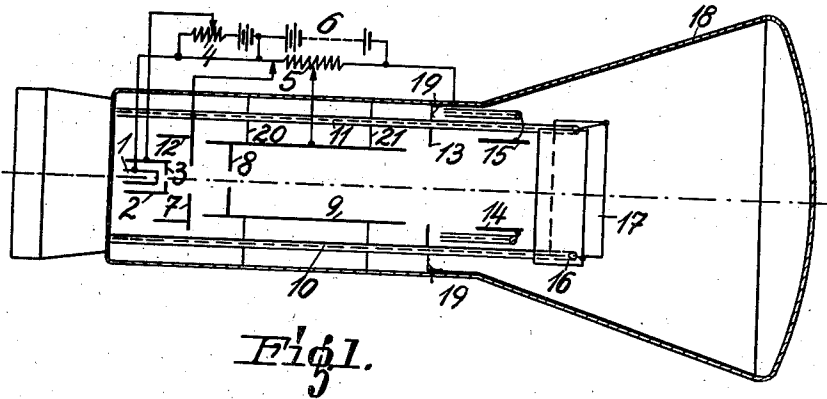


Fig. 1.

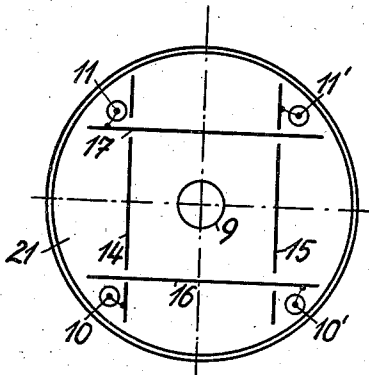


Fig. 2.

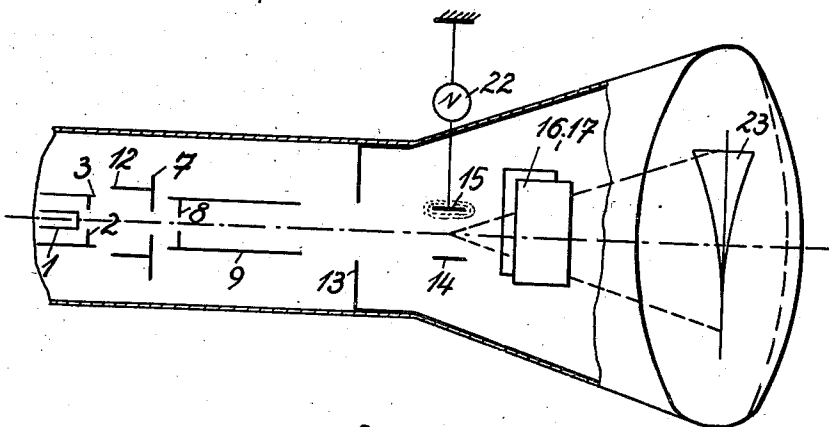


Fig. 3.

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2 Sheets-Sheet 2

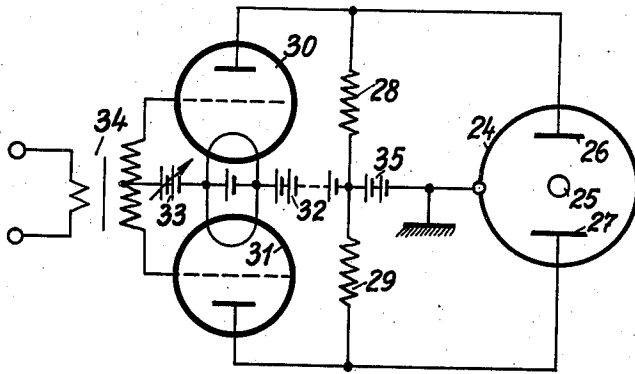


Fig. 4.

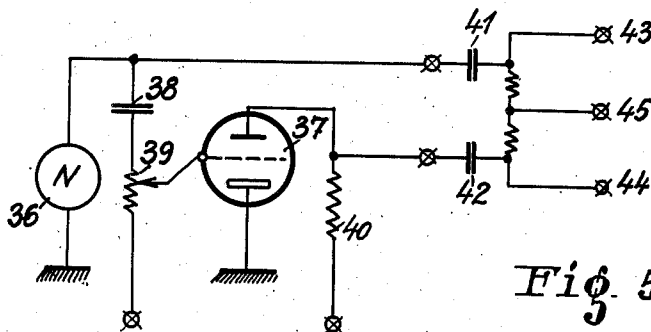


Fig. 5.

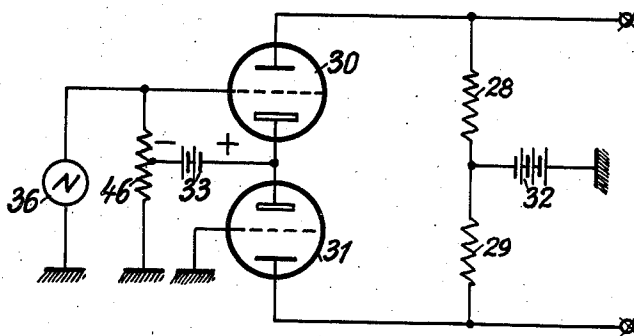


Fig. 6.

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UNITED STATES PATENT OFFICE

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TELEVISION TUBE

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mesne assignments, to Loewe Radio, Inc., a cor-
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Application November 21, 1934, Serial No. 754,048
In Germany November 10, 1933

1 Claim. (Cl. 178—7.7)

The invention relates to Braun tubes for tele-
vision purposes comprising an electrostatic elec-
tron-optical system for producing sharp image
points and electrostatic scanning deflecting sys-
tems and two arrangements including such
Braun tubes.

Braun tubes of this kind are already known.

In the known tubes of this kind, however, two
difficulties arise simultaneously, namely

(1) The difficulty of avoiding losses in inten-
sity of the cathode ray arising from parts of the
electrons of the beam being intercepted at the
electrodes of the electron-optical system, and

(2) Difficulties in operation resulting inter
alias in that the produced television picture is
unsharp at its edges. The applicant has found
that this unsharpness is caused by an undesired
influence of the electrostatic deflecting systems
upon the electrostatic electron-optical system.

One object of the invention is to provide a
Braun tube for television purposes comprising an
electrostatic electron-optical system and wherein
means are provided for preventing an inter-
ception of electrons at said system as well as at
the electrodes mounted between said system and
the cathode.

Another object of the invention is to provide a
Braun tube for television purposes comprising an
electrostatic electron-optical system and electro-
static deflecting systems for the purpose of de-
flecting the ray for scanning the picture receiv-
ing screen and wherein an influence of said elec-
trostatic systems upon one another is prevented.

A further object of the invention is a circuit
for operating such Braun tubes.

Still further objects of the invention will be
seen from the following description.

The invention is described more particularly
with reference to the appended drawings, which
illustrate by way of example one embodiment of
the television tube according to the invention and
several circuits for operating the same. It will be
understood that the numerical data given in the
following are given by way of example only and
that the invention is not restricted to them.

Fig. 1 shows a cross-section of a Braun tube
according to the invention.

Fig. 2 shows a view of the electrode system
from the front side.

Fig. 3 illustrates the distortion occurring in
the tubes known heretofore, which is prevented
by the invention.

Figs. 4-6 show some embodiments of circuits
for operating the Braun tube; in

Fig. 4 the principal idea of the invention is
shown, while in

Fig. 5 a circuit is shown wherein a so-called
phase reversing tube is employed.

Fig. 6 shows a circuit operating without a phase
reversing tube.

In the figures 1 is a glow cathode, 2 a per-
forated control plate or grid arranged in front
of the cathode for controlling the intensity of
the cathode ray. In front of the grid there is
situated a small metallic rim 3, which may be
part of a metallic cylinder surrounding the cath-
ode and the control electrode. 9 is a tubular
electrode arranged between the control grid and
the anode 13. The electrode 9 is supplied by
means of a potentiometer arrangement 5 with a
potential which is lower than the maximum po-
tential of the potential source 6 amounting to
approximately 1000-10,000 volts. The combina-
tion of the electrode 9 with the anode 13 repre-
sents the reproducing electron-optical system of
the tube. The electrons in the first instance are
preliminarily accelerated by the suction anode 7
furnished with a large aperture (2-4 mm. bore).
The object to be reproduced is represented by
the aperture of the diaphragm 8; the size of
this aperture depends upon the size of the image
point to be produced (of the order of .5 mm.).
The aperture in the diaphragm 8 is furnished
with that particular geometric form which it is
desired to impart to the image point.

It should be noted that the combination of
the electrodes 2, 3, 7 and 8 also constitutes a kind
of an electron-optical system.

Appreciable difficulties are encountered in
causing all of the electrons leaving the electrode
3 pass simultaneously, without interception,
through the narrow aperture of 8 and later
through the rear diaphragms of the tubular
member and the deflecting plates.

According to the invention the tube is so con-
structed that the electrons do not come to a
focus in the space between 1 and 8 nor in the
aperture of 8. For this purpose the concentrating
forces of the optic 2, 3, 7, 8 are to be made so
small that the rays at the most run parallel or
otherwise diverge slightly towards the diaphragm
8. In the arrangement as shown there is an
appreciable refractive power between the elec-
trodes 2, 3, 7. This preliminary concentration is
the greater the more the metallic rim 3 pro-
jects beyond the grid 2 and the greater the dif-
ference in potential between 3 and 7 or the
smaller the distance between 3 and 7. Accord-
ing, therefore, to the invention, the latter dis-

tance is selected to be comparatively large, for example, approximately 5-10 mm., and the length of the rim 3 relatively small (approximately 2 mm.) with a difference in potential amounting to a few hundred volts. In general terms the diameter of the control cylinder 2 and the distance between cylinder and preliminary anode 7 are of the same order, and the height of 3 is one third thereof or less. The preliminary concentration naturally varies somewhat with the control at the grid 2. According to the invention, the entire optic should be so adjusted by correct selection of the stated dimensions and biases that in the position "white," i. e., with maximum intensity of the ray current, the diameter of the cathode ray bundle is at a minimum at the diaphragm 8. In practice this minimum is of the same order as the cathode spot.

With given dimensions of the condenser optic 2, 3, 7 it is also possible in accordance with the invention to obtain correct adjustment of the passage of the ray by simultaneously so varying in common the two biases of the suction anode 7 and the grid cylinder 2, 3 with the assistance of the two potentiometers 5' and 4 that the intensity of the ray current, and accordingly the control potential $-e_g + D \cdot e_a$ remains constant, whilst the values e_g and e_a increase or decrease singly. By this measure it is possible in each case to obtain a correct lighting of the diaphragm aperture 8 with rays having the least possible divergence.

The distance of the diaphragm 8 from 7 and 2 is found by dioptric construction, and in the passage of the rays according to the invention, and may be selected to be all the smaller without cutting or intercepting of the rays, and accordingly the thicker the bundle may be allowed to be in the rear parts of the bulb of the tube. According to the invention, the use of a narrow bundle is preferable and therefore the distance 2, 8 is selected comparatively long, i. e., approximately 20-30 mm. in length; in this case, i. e., when using narrow bundles, the deflecting plates may be positioned more closely together in the rear part of the tube and thus made more sensitive. A further advantage consists in that the deflection of narrow bundles through lenses with limited aperture is more readily possible than in the case of very wide bundles. The tubular member 9 is passed on the one hand up to the anode 7, or may be electrically connected therewith. This serves to withhold electrostatic transverse fields, which might result from leads 10 and 11 to the more highly tensioned electrodes of the tube. For the same purpose a screen 12 between the suction anode 7 and the control grid 2, 3 is provided. The electrostatic lens is formed by the front edge of the tubular member 9 in conjunction with a large diaphragm 13. The aperture of the lens, according to the invention, is determined under consideration of the thickness of the bundles of rays, which in turn is calculated from the dioptric effect 1, 7, 8. This aperture is provided with a diameter of such size that all rays pass clearly through, but is made so small that the reciprocal of the field of the next adjacent deflecting plates 14, 15 into the interior of the tubular member 9 is very small. In practice the diameter of 9 will be 20 mm., the diameter of 13 of the same order, and the spacing between the two approximately 5-10 mm. Between the deflecting plates 14 and 15 and the diaphragm 13 there is provided a

safety spacing, which must be approximately equal to the spacing of the plates from one another. By this construction and arrangement of the anode 13 and the deflecting plates 14, 15 with respect to one another the influence of the deflecting field upon the electrostatic lens 9, 13 is greatly reduced. The diaphragm 13 and the plates 14, 15, 16, 17 are supported by four glass tubes, in the interior of which there are located the leads to the deflecting plates 14-17. The diaphragm 13 is raised to the same potential as a silvered portion in the rear part of the bulb 18. The connection between the two is produced by wiper springs 19. The tubular member 9 is secured to the glass tubes with the use of two or more guide collars 20, 21; in this way the necessary optical alignment of the parts of the system may be obtained in simple fashion. The four glass tubes containing conductors 10, 10', 11 and 11' are so strongly dimensioned that the deflecting system 14, 15, 16, 17 may be suspended thereon in cantilever fashion and that the whole may be introduced from the rear into the bulb.

Fig. 2 shows a view of the system from the front. There are to be seen the four deflecting plates 14, 15, 16 and 17. There are also to be recognized the four insulating tubes in the interior of which there are situated the leads 10, 11, 10', 11', to the plates. There are also shown the guide rings 20, 21, which surround the tubular member 9 and are bored to receive the four insulating tubes.

As regards the operation of this tube, mention requires to be made of the following measure according to the invention: despite the stated safety distance between the deflecting plates 14, 15 on the one hand and the limiting electrode 13 of the lens on the other hand it has been found that the marginal field of the deflecting plates acts detrimentally on the extent of the effective refractory power of the electronic lens and that, therefore, there is a lack of sharpness at the edge of the image. This may be overcome according to the invention by either making the stated distances equal to or greater than approximately twice the distance of the plates or operating the plates fundamentally in counter-cadence (push-pull). The term "operating in counter-cadence" is intended to mean that one deflecting plate is supplied with a scanning voltage and the other plate with a voltage of the same frequency and amplitude as said scanning voltage but of reverse phase. That which applies to the distance between 13 and plates 14, 15 also applies to the spacing between the two pairs of deflecting plates 14, 15, and 16, 17. The trapezoidal error, which is unavoidable if the latter distance is insufficient, may also be completely overcome by counter-cadence operation of both pairs of plates. It is then and only then that the possibility exists of managing with small relative spacings between these pairs of deflecting plates.

Fig. 3 serves to explain matters in this connection. The same shows the static lens 9, 13 on the one hand and the deflecting plates 14, 15 next adjacent thereto on the other hand. If the plate 14 is earthed and the plate 15 positively biased with respect to 13, for example by the deflecting voltage generator 22, there is superposed to the original lens potential in the upper part of the figure a positive marginal field potential. The cathode ray, i. e., the point under observation, moves, however, exactly into

this disturbed field. The plane of reproduction is situated in this case in front of the luminous screen and the image point lacks sharpness. The conditions are considerably more favourable in the case when the deflecting plate 15 is negatively charged. In this case there certainly also occurs a disturbance of the lens effect in the upper part of the drawing due to the diminution of the refractive power of the lens, but the point, viz., the cathode ray, moves naturally out of this field of disturbance, since it approaches the plate 14 which is earthed.

The error in reproduction is illustrated on exaggerated scale by the diagram 23 in Fig. 3, which diagram reproduces as shown by experiment in which way the width of the image point on the luminous screen is dependent on its particular position. This error becomes smaller if, as already set forth, the reciprocal of the plate field into the lens 9, 13 is reduced either by moving the plates away from the lens or, preferably, by narrowing the diameter of the lens, but cannot be overcome entirely by purely structural measures.

The error is so considerable in practice that it rendered impossible the use of similar (i. e., electro-static or magnetic) fields simultaneously for concentrating and deflecting purposes in high-vacuum tubes.

Careful investigations by the applicant have shown that this error may be overcome by the use of special kinds of deflecting fields.

According to the invention, there are employed for this purpose either

(a) deflecting fields, which do not cause any perceptible disturbance of the lens field at all, or

(b) deflecting fields, which certainly cause disturbance of the lens field, but in which they affect only that part of the lens field out of which the ray has just moved, so that the disturbance of the lens field does not result in practice in disturbance of the concentration effect.

Deflecting fields of the kind under (a) may be produced, for example, by counter-cadence operation of the plates 14, 15, in which to the one plate there is conducted the deflecting potential and to the other plate a potential of equal amplitude but reversed phase, so that the one plate in relation to its surrounding always becomes more positive to the same extent to which the potential of the other plate passes into negative.

When employing deflecting fields of this nature the interference is greatly decreased, as the potential remains permanently chronologically constant in the middle line of the whole tube (potential of a di-pole).

Several circuits for an operation of this character will be described in the following.

The principle is described more particularly with the assistance of Fig. 4. In the same 24 is the anode of a Braun tube, out of the aperture of which the ray 25 is assumed to pass vertically to the plane of the paper. This anode 24, as before, is earthed. The deflecting plates 26 and 27 are each connected over a resistance 28 respectively 29 with earth and anode. The two amplifier tubes 30 and 31 shown in the drawings are energized with their cathodes negative with respect to earth by the potential E_a as supplied by means of a battery 32; their grids are biased negatively in such fashion against the cathodes by means of a grid battery 33 ($-E_g$) so that in the state of rest no appreciable current flows

through the tubes. Dynamically the two grids are operated in counter-cadence, which in the case of a frequency range which is not excessive may readily be accomplished by means of a counter-cadence or push-pull transformer 34.

The operation of this amplifier in itself is identical with that of the so-called B-amplifier known in the power amplification art. For the purpose of operating a cathode ray tube according to the invention the same, however, offers the following advantages:

1. The cathode ray is moved only by repulsion. One of the two plates, for example 27, is always connected dynamically with the last electrode passed through by the cathode ray before entering into the deflecting system, e. g. to earth, if, as shown in the drawings, that last electrode (24) is earthed, whilst the oscillation plate 26 oscillates only into negative, and vice versa. In consequence the oscillation plate does not take over any cross-current at all, and also the particular earth plate, since the same never becomes positive in relation to the ray, remains substantially free of cross-current. Traces of cross-current may be avoided according to the invention by making the anode somewhat positive in relation to the two plates in the state of rest by a slight potential 35 amounting to approximately 1% of the anode potential. The deflection, therefore, is wattless since no electrons are intercepted by the plates.

The term "state of rest" is herein intended to mean that state in which no scanning voltage at all is applied to the deflecting plates.

2. Small power input: The current taken from the anode battery 32 is proportional to the deflection amplitude. Since there is no flow of cross-current, the resistances 28 and 29 may be made as highly ohmic as allowed by the parallel reactances in the case of the operating frequency. There are accordingly selected, for example, for 28 and 29 values between .05 and .5 megohm. Since the battery 32 is required to supply merely very weak currents, there may be employed as such according to the invention the anode battery of the Braun tube (see Fig. 5).

3. Sensitiveness. With an anode potential of E_a volts a deflection may be obtained which corresponds with the total range of movement $2E_a$.

4. Image point displacements by reason of cross-current are completely avoided.

5. There are no condensers between the anode resistances 28 and 29 and tube plates 26 and 27; the circuit, therefore, reproduces also D. C. values on the anode side.

Upon using the same circuit for deflecting the cathode ray in both directions (perpendicular to each other) errors in the so-called trapezoidal errors, are in contradistinction to the normal method symmetrical to the middle point, so that deviations from the ideal rectangular form of image become smaller and practically negligible.

In the case of dissimilarity in the form of curve at the lower bend of the valves 30 and 31 there may be lack of linearity in the vicinity of the zero point. According to the invention the grid bias 33 is made to be variable, and the optimum thereof is adjusted in each single case. An additional improvement may be obtained with the use of multi-system valves comprising two exactly equal preferably cylindrical electrodes systems, each system possessing a separate cathode.

In the case of large widths of frequency band the use of a counter-cadence or push-pull trans-

former (34) may prove to be impossible. In this event the generation of the counter-cadence grid potentials for tubes 30 and 31 may take place by means of a phase-reversing tube. A circuit of this kind is shown in Fig. 5. In the same 36 is the generator, for example, a relaxation oscillation generator producing oscillations of a maximum amplitude of, say, 10 volts. The grid of a tube 37 is supplied through the medium of a condenser 38 and potential distributor 39 with a part of this potential, and supplies at a small anode resistance 40 (approximately 2000 ohms) a potential, which is equal in amount to the potential 36, but possesses the opposite phase. The alternating potentials are passed via the condensers 41 and 42 to the points 43 and 44, that is to the two grids of the counter-cadence valves 30, 31 in Fig. 1, whilst the point 45 is connected to the grid battery (33 in Fig. 4).

The arrangement according to Fig. 6 may be operated without a special phase-reversing tube 37 if indirectly heated cathodes are employed and the grid of the tube 31 is earthed. In this case the generator 36 will be provided with a comparatively small resistance 46 (of the order of 1000-5000 ohms), the centre of which is connected to the two cathodes of the tubes 30 and 31, whilst the grid of the valve 30 is connected with the full potential produced by 36, and the grid of 31 is earthed. The bias is again obtained from a battery 33. The functions of the connection system are the same as those in Fig. 4. There may be obtained, however, altogether merely half the degree of amplification obtainable in that case. The maximum potential amplitude of the output circuit is the same. The advantage of input control without power output is, however, lost, as the resistance 46 is small as compared with the resistances 28 and 29, i. e., is itself not highly ohmic.

By means of the counter-cadence operation it is further possible, in addition to overcoming the error which it is sought to remove in accordance with the invention, to double the sensitiveness of the tube. In addition the same also permits of a compact form of construction of the tube, and ensures complete elimination of the trapezoidal error.

Deflecting fields of the kind set forth under (b), above may be produced by employing for control purposes solely negative plates, i. e., by charging on each occasion the plate 14 and the plate 15 negatively in succession, the other plate being 5 passed to earth.

Since in the case of this arrangement the cathode ray always approaches the particular plate which is earthed, the same is conducted out of the disturbed lens field, so that interference of the concentration effect is unable to occur also in the case of this operation according to the invention. 10

Contrary to expectations, however, it has been found that in most cases it is already sufficient to operate in countercadence the pair of plates situated next to the lens. 15

It should be noted that the principles of the invention in connection with electrostatic arrangements, as set out in the above, may be applied also to magnetic arrangements. 20

I claim:

A cathode ray beam deflecting system comprising a cathode ray tube having means including an accelerating anode to produce a narrow focussed beam of electrons, a pair of deflecting plates associated with the produced beam and adapted for causing deflection of the beam, a pair of reactance elements connected in series across said plates, a source of potential for maintaining the junction of the reactance elements negative with respect to the accelerating anode of the cathode ray tube, a pair of discharge tubes each having a cathode, a control electrode and an output electrode, means for directly connecting the output electrode of each tube to one of the deflecting plates, means for maintaining the cathodes of the tubes at a negative potential with respect to the junction of the reactance elements, and means for applying push-pull voltage variations to the control electrodes of the discharge tubes, whereby the deflecting plates are always negative with respect to the accelerating anode of the cathode ray tube by an amount at least as great as the value of the first-named source of potential. 25 30 35 40 45

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