Dec. 3, 1940. K. SCHLESINGER 2,224,116

RELAXATION APPARATUS

Filed June 7, 1938 2 Sheets-Sheet 1

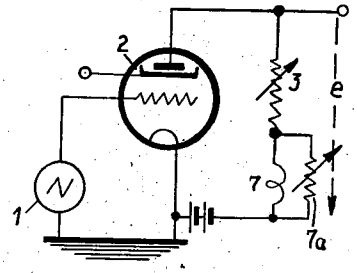

Fig. 1

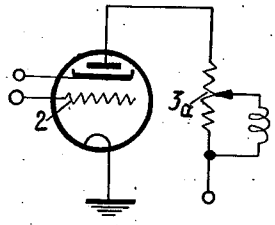

Fig. 1a

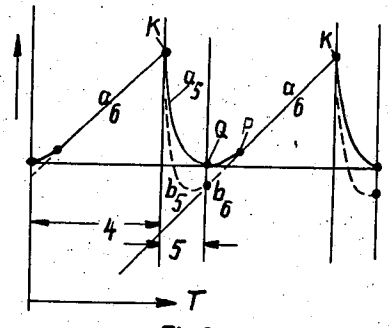

Fig. 2

Inventor:

Karl Schlesinger

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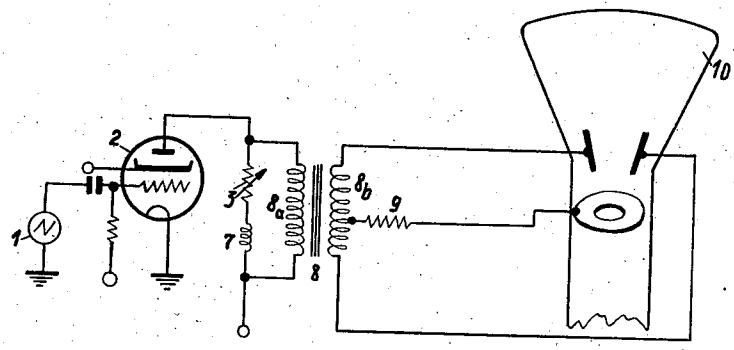

Fig.3

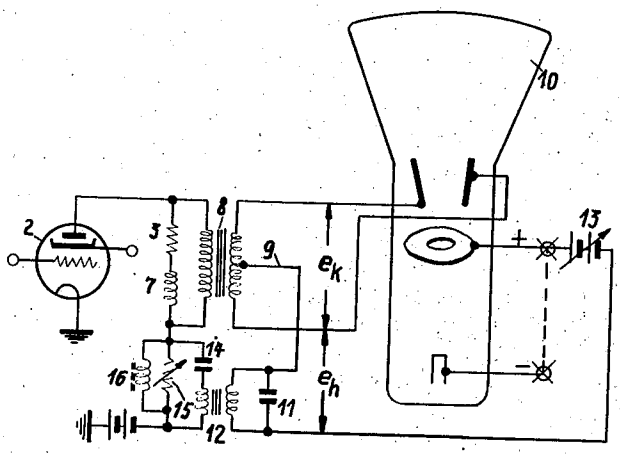

Fig.4

Inventor:

Kurt Schlesinger

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UNITED STATES PATENT OFFICE

2,224,116

RELAXATION APPARATUS

Kurt Schlesinger, Berlin, Germany, assignor, by mesne assignments, to Loewe Radio, Inc., a corporation of New York

Application June 7, 1938, Serial No. 212,317
In Germany June 10, 1937

10 Claims. (Cl. 178—69.5)

Higher demands are continuously being placed on linearity of the deflection of cathode rays in television and oscillograph design. Particularly in the utilisation of large amplitudes the natural deviations from the linearity, caused for example by the curvature of the tube characteristic, must, therefore, of necessity, make themselves noticeable in more and more interfering form. In modern television tubes with very short index length, in which the width of the picture is already approximately equal to the index length of the cathode ray, and angles of deflection of $2 \times 20°$ occur, the end tubes of the relaxation transformer or the relaxation magnet coil must already be controlled to full extent and it is accordingly impossible any longer to effect limitation to the middle linear portion of the characteristic, as the anode outputs which would then require to be employed would already come within the order of 20–40 watts.

The applicant has found a method which enables the non-linearity in the lower band of the tube characteristic to be eliminated. The method operates with the inclusion of tuned self-inductions in the anode circuit of the end stages and utilises the natural oscillation of these self-inductions. The basic features are explained by Figs. 1 and 2.

In Fig. 1, for example, 1 is the symbol for a relaxation oscillation generator for ideal sawtooth curves. This generator may consist, for example, of a condenser, which is charged by way of a resistance and is discharged by a parallel-connected gas-filled grid-controlled electronic discharge tube. If with this linear grid potential there is controlled an end tube 2, which is shown to be a pentode, for the purpose of being able to regard the anode circuit as being controlled in non-reactive fashion, and if in the anode circuit there is merely an ohmic resistance 3, the anode alternating potential corresponds to the curve a_5/a_6 in Fig. 2. The curve ascends in linear fashion in the zone 4 up to the relaxation point K, then descends exponentially in the zone 5 corresponding to the discharge of the condenser, and includes at point Q a portion which is useless for television purposes and is caused by the curvature of the tube characteristic in the case of negative biasses. As the applicant has found, it is, however, possible by the inclusion of a coil 7 in series with the anode resistance 3, which coil is tuned with its natural periodicity approximately to the duration of the return 5, to obtain an anode potential curve according to the curve b_5/b_6. Upon the interruption of the anode current of the tube 2 the coil 7 oscillates for a certain time with its natural oscillation beyond the zero line of the potential. If the anode resistance 3 is exactly adapted in size, it may be accomplished that the portion b_6 of the potential curve of the coil always lies with equal ascent at the point P against the normal portion a_6. The portion b_6 is accordingly still capable of being employed for television purposes, and the deflection coordinate thus obtained may provide for up to 50% of the total image deflection dependent on the ratio between coil impedance and series resistance 3. There is to be observed as additional advantage upon the connection of suitably selected oscillatory chokes 7 an acceleration of the return portion b_5. It will be clear in the matter of connections that that which is attained in the anode circuit by means of coils can also be accomplished in the grid circuit by other connection elements. An essential feature is the lifting of high frequency in the train of the amplification between relaxation potential generator and relaxation potential consumer.

In Fig. 3 there is shown by way of example the use of the anode oscillatory choke when employing a relaxation transformer. The relaxation transformer 8 taps on the primary side the potential e, which is additively composed of the resistance potential 3 and the oscillatory choke potential 7, in which connection its primary impedance must be fundamentally large as compared with the total maximum impedance of the series connection 3/7. In this case the secondary potential becomes an image of the primary potential, and accordingly is as indicated in Fig. 2. It has been found that as sole interference upon the transformation the secondary winding 8b may in certain circumstances commence to oscillate with its natural oscillation, the frequency of which is governed by its self-induction and the associated wire capacities. These natural oscillations can be eliminated entirely by the inclusion of a damping resistance 9 in the lead to the anode of the television tube 10, i. e., at the neutral centre.

To quote numerical examples, the applicant has ascertained, when using 450 lines and 50 images per second, an anode resistance 3 of 1,500 ohms in conjunction with a coil 7 having a natural periodicity of approximately 10^{-5} seconds, in which connection the adjustment of the resistance 3 requires to be made exactly to within $\pm 15\%$ in order to ensure that the potential portion b_6, which is due to the coil, merges on to the potential portion a_6 without a break in continuity and with constant slope.

In this connection it may be remarked that the adjustment of the transition point can also be influenced by a resistance 7a in parallel with the choke (Fig. 1). In the most general case series and parallel damping, in accordance with Fig. 1a, can be merged one into the other with

the aid of a potentiometer, in which connection it is certainly always a condition that the natural periodicity of the coil has been correctly tuned at the outset, i. e., made approximately to coincide with the expected duration of the return. The potentiometer 10 in Fig. 1a would act in such fashion that when the wiper is right at the bottom a relaxation curve results which is purely ohmic, i. e., is distorted in the lower bend, whilst upon location of the wiper at the upper end the anode circuit is substantially purely inductive. In this case there results the differential curve of a sawtooth curve, which is composed solely of impulses and accordingly in turn is also useless for television purposes. The resistance value in the assumed example would amount to approximately 3,000 ohms, and the coil would require to be furnished with a winding area of approximately 400 turns times 1 square centimetre with an iron powder core.

The modern development of the electrostatic deflection to wide-angle deflection led to a connection system which is set forth in Fig. 4, in which connection it was necessary to dispose a rectifying auxiliary potential e_h below the normal counter-cadence deflection potential e_k. It has been set forth in an earlier application (see Ser. No. 203,487, corresponding to German application R99,203) that this auxiliary potential e_h must be in amount equal to half the amplitude of e_k and in form such that it results in a distinctly positive maximum in the case of both edges of the picture. It has also been disclosed that a curve of this character can be produced from a sawtooth curve by causing a capacity of suitable size, which is designated 11 in Fig. 4 to be charged by a potential source which has itself a sawtooth form. This is shown in Fig. 4 in the form of the auxiliary transformer 12. Since only a potential free of direct current can result at the terminals of the condenser 11, it is necessary upon the wide-angle correction to supply to the television tube 10 an auxiliary potential 13 of slight positive value beyond the anode potential, so that the summit of the correction parabola just reaches the anode potential, which is equivalent to sharp adjustment of the centre of the image.

The point of interest in the present connection is the fact that the phase of the primary potential of the rectifying transformer 12 must be advanced in relation to the current phase of the anode current of 2 when employing the pupinization of the main relaxation circuit by the oscillatory choke 7 according to the invention. As can be recognized from the time curve in Fig. 2, the commencement of the relaxation curve is apparently displaced towards the left when employing the oscillatory choke. In a manner of speaking, therefore, the phase of the relaxation initiation is advanced, and it is accordingly necessary to advance by the same amount the phase of any rectifying auxiliary potentials, which should run synchronously to the relaxation curve. This is carried out in practice by connecting the condenser 14 in series with the primary winding of 12. The amount of the rectifying potential can be adjusted by the shunt 15, and the drop in direct current which would otherwise occur at the resistance 15 amounting to approximately 1,000 ohms can be avoided by a bridging choke 16, which does not take part itself in the oscillation, and the natural oscillation of which is accordingly much lower than the line period.

To quote figures, in an embodiment complying with the conditions above referred to,

The transformer 12 had 2,000 primary turns with a transformation ratio of 1:3:

The integration condenser had 200 cm., so that the natural oscillation of the secondary winding was of the order of the line period, i. e., approximately 12,000 cycles.

In these circumstances the phase condenser 14 required to be finely adjusted between 4,000 and 6,000 cm., whilst the primary resistance 15 was of the same order as the main working resistance 3, viz., approximately 1,000 ohms. The gain in potential of 1:2.5 was again consumed in such fashion by the loss of potential upon the integration, i. e., upon the charging of the condenser 11, that the said ratio: correction=one-half of deflecting potential was brought about. The auxiliary potential 13 in turn is equal to approximately one-third of the rectifying potential, i. e., equal to one-sixth of the deflecting potential, which may be directly deduced from calculation of the mean value of the direct current contained in a parabola.

I claim:

1. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic.

2. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, said means consisting of a choke being connected in series to the anode-resistance of the amplifier the natural oscillation of which has a frequency corresponding to the return period of the relaxation oscillation.

3. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, said means consisting of a choke being connected in the anode circuit of the amplifier in series to a variable resistance.

4. An arrangement for synchronising a tele-

vision receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, said means consisting of a choke being connected in the anode circuit of the amplifier in parallel to a variable resistance.

5. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, said amplifier being a pentode.

6. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, the output of said amplifier being coupled to said deflection elements by a transformer, the secondary of which is connected in push-pull to the deflection elements.

7. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, the output of said amplifier being coupled to said deflection elements by a transformer, the secondary of which is connected in push-pull to the deflection elements, the primary of which has an impedance being large as compared with the impedance of the anode resistance comprising said choke, and is connected in parallel to said anode resistance.

8. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification and comprising means for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic, the output of said amplifier being coupled to said deflection elements by a transformer, the secondary of which is connected in push-pull to the deflection elements, said secondary having a middle common terminal and two outer terminals, said middle common terminal being connected to the anode of said cathode ray tube by a damping resistance, the outer terminals being connected to said deflection elements.

9. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, the output of said amplifier being connected to the primary windings of two transformers, said primary of the first transformer being connected in series to the primary of the second transformer in the anode circuit of said amplifier, the secondary of the first transformer being connected in series to the secondary of the second transformer in such a manner, that a correction voltage is superposed to the deflection voltage arriving at the deflection elements, in the primary circuit of the second transformer phase shifting elements being provided for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic.

10. An arrangement for synchronising a television receiver having a source of synchronising signals, a relaxation oscillation generator, and an amplifier, the input of which being coupled to the output of said generator, the output of which being coupled to the deflection elements of a cathode ray tube, said amplifier being so biassed that at least the nearly complete non-linear lower part and the linear upper part of the valve characteristic, are used for the amplification, the output of said amplifier being connected to the primary windings of two transformers, said primary of the first transformer being connected in series to the primary of the second transformer in the anode circuit of said amplifier, the secondary of the first transformer being connected in series to the secondary of the second transformer in such a manner, that a correction voltage is superposed to the deflection voltage arriving at the deflection elements, in the primary circuit of the second transformer phase shifting elements being provided for removing the distortion of the amplified oscillations effected by the amplification in the lower non-linear bend of the characteristic as shown in the television image, said phase shifting elements comprising a condenser connected in series to the primary of said second transformer and having such a capacity that said primary circuit oscillates at least about in resonance to the basic period of relaxations oscillation.

KURT SCHLESINGER.