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W. A. TOLSON

2,183,340

DEFLECTING CIRCUITS

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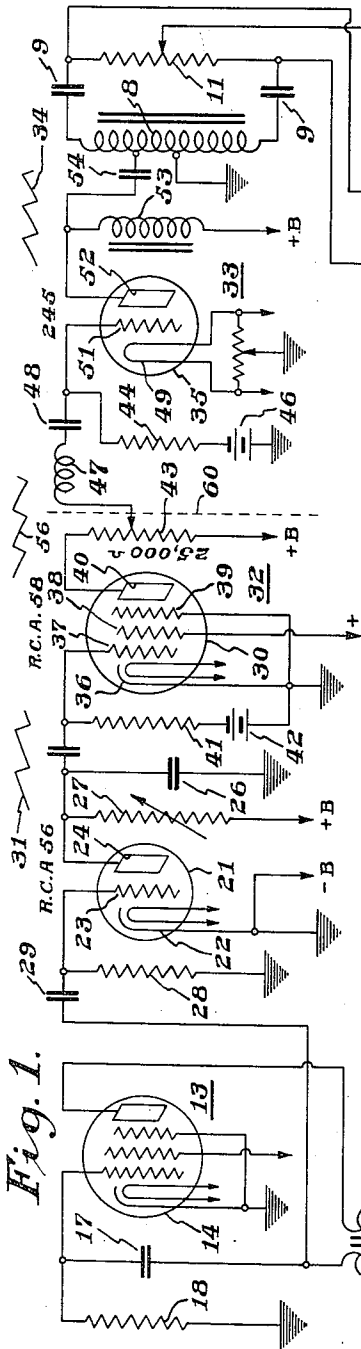


Fig. 1.

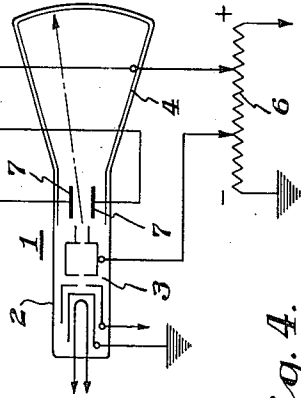


Fig. 2.

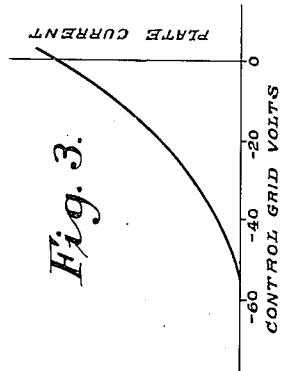


Fig. 3.

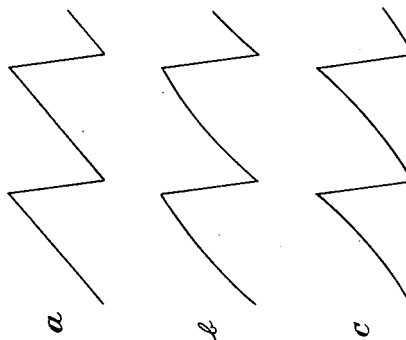
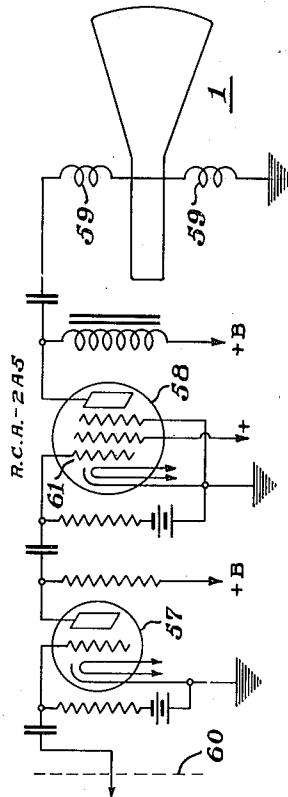


Fig. 4.



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DEFLECTING CIRCUITS

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Application April 27, 1935, Serial No. 18,491

7 Claims. (Cl. 250—27)

My invention relates to cathode ray tube deflecting circuits and particularly to deflecting circuits adapted to provide either a voltage or a current having a saw-tooth wave form.

5 In a deflecting circuit designed to apply a saw-tooth voltage to cathode ray tube deflecting plates, it is desirable to step up the voltage by means of a transformer before it is impressed upon the plates. Since a voltage of this wave
10 form includes a wide band of frequencies, 8000 cycles per second to 100,000 cycles per second, for example, and since the step-up ratio should be maintained at approximately 5 to 1, the problem
15 of designing a suitable transformer is a difficult one. Even the best transformers distort a voltage wave a certain amount so that, if a perfect saw-tooth voltage wave is impressed upon such a
20 transformer, the saw-tooth wave appearing at the output terminals is curved or bent over. This distortion of the saw-tooth wave is caused primarily by phase shift at the lower frequencies.

If magnetic deflection is employed, the use of a step-up transformer is not required but it is found that a different source of distortion is effective in a magnetic deflection circuit. The deflect-
25 ing coils themselves appear to introduce distortion whereby the saw-tooth wave form of the deflecting coil current is bent over just as a saw-tooth voltage wave is bent over by a transformer.
30 An object of my invention is to provide an improved cathode ray tube deflecting circuit.

A further object of my invention is to provide an improved method of and means for supplying a cathode ray deflecting field of substantially pure
35 saw-tooth wave form.

A further object of my invention is to provide an improved deflecting circuit in which a cathode ray is deflected by means of electrostatic deflecting plates.

40 A still further object of my invention is to provide an improved deflecting circuit in which a substantially pure saw-tooth voltage wave may be obtained from the output terminals of a transformer.

45 A still further object of my invention is to provide means for compensating for distortion introduced into a saw-tooth voltage wave by a transformer.

In the preferred embodiment of my invention
50 I produce a voltage wave having a substantially pure saw-tooth wave form and pass it through an amplifier tube which distorts the saw-tooth in a direction opposite to the distortion produced in the step-up transformer or in the deflecting coils.
55 The distorted saw-tooth wave is then supplied

through an output tube to the transformer and deflecting plates or to the deflecting coils wherein it is again distorted, but in the opposite direction, with the result that a substantially perfect saw-tooth deflecting field is obtained.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which—

Figure 1 is a circuit diagram of a portion of 10 the television receiver embodying my invention.

Fig. 2 is a group of curves which are referred to in explaining the invention.

Fig. 3 is a characteristic curve of one of the tubes shown in Fig. 1, and

Fig. 4 is a circuit diagram of an electro-magnetic deflecting circuit which may be substituted for a portion of the circuit shown in Fig. 1.

Referring to Fig. 1, one embodiment of my invention is shown applied to the horizontal deflecting circuit of a television receiver. The receiver includes a cathode ray tube 1 of a well known type which comprises an evacuated envelope 2 having therein an electron gun 3 and a second anode 4 which functions both to accelerate the electrons and to focus the electron beam electrostatically. Suitable voltages are applied to the cathode ray tube electrodes from any suitable source exemplified by the voltage divider 6.

The cathode ray tube 1 is provided with electrostatic deflecting plates 7 for deflecting the cathode ray. The deflecting plates 7 are supplied with a saw-tooth voltage through an autotransformer 8, the deflecting plates being connected across the secondary of the transformer 8 through blocking condensers 9. A resistor 11 is connected across the deflecting plates and the second anode 4 is connected to its mid-point. By employing this circuit, defocusing of the cathode ray during deflecting is avoided. This particular deflecting circuit is described and claimed in my copending application, Serial No. 737,163, filed July 27, 1934 and assigned to the same assignee as this application.

As previously stated, the transformer 8 is necessary in order to obtain a sufficiently high voltage across the deflecting plates, but its use results in distortion of a saw-tooth voltage wave. The way in which the transformer distorts the voltage wave will be seen by referring to Fig. 2. If a voltage having perfect saw-tooth wave form as indicated by the curve *a* is impressed across the primary of the transformer 8, the voltage appearing across the secondary will have the wave form indicated by the curve *b*. It will be noted

that the transformer causes the saw-tooth to bend over at the top.

In accordance with a preferred embodiment of my invention I generate a voltage wave having a substantially perfect saw-tooth wave form, distort this wave form in a manner to compensate for distortion in the transformer, and then impress the distorted saw-tooth voltage across the primary of the transformer. The saw-tooth voltage may be generated in any suitable circuit. In the circuit illustrated, the means for producing an undistorted saw-tooth voltage comprises a blocking oscillator 13 of the type described and claimed in Patent No. 2,101,520, issued December 7, 1937 to W. A. Tolson and J. R. Duncan and assigned to the same assignee as this application.

The oscillator 13 includes a tube 14 having a plate circuit which is coupled to the grid circuit through a transformer 16 whereby a grid condenser 17 is caused to charge and periodically block the tube. After the tube 14 blocks, the charge on the grid condenser 17 leaks off through a grid resistor 18 whereby the tube is unblocked to permit the next blocking cycle. The oscillator supplies voltage impulses at a rate determined by the oscillator constants and, in the case of a television receiver, by synchronizing impulses which may be applied through a coupling condenser 19.

The saw-tooth voltage generating circuit also includes an impulse tube 21 which may be of the three electrode type comprising an indirectly heated cathode 22, a control grid 23 and a plate 24. In the output circuit of the tube 21 a condenser 26 is connected between the plate 24 and ground. Voltage is supplied from any suitable voltage source to the plate 24 and to the condenser 26 through a high impedance resistor 27 whereby the condenser 26 is charged gradually to produce a portion of the voltage saw-tooth.

In the input circuit of the tube 21, a grid resistor 28 is connected between the grid 23 and the cathode 22. The blocking oscillator 13 is coupled to the grid 23 through a coupling condenser 29 whereby positive voltage impulses are applied to the grid 23 periodically. Each time a positive voltage impulse is applied to the grid 23 the impedance of the tube 21 is made so low that the condenser 26, which has been charged through the resistor 27, discharges very rapidly through the tube to produce the return line portion of the saw-tooth. From the foregoing description it will be apparent that the voltage appearing across the condenser 26 has a substantially perfect saw-tooth wave form as indicated by the curve 31 and by the curve *a* in Figure 2.

The saw-tooth voltage is supplied to the primary of transformer 8 through an amplifier stage 32 including a tube 30 and an output stage 33 including a tube 35. The amplifier stage 32 is so designed that it distorts the wave form of the voltage appearing across the condenser 26, this distortion being such that the wave form of the voltage impressed upon the transformer primary has the general shape indicated by the curve 34 and by the curve *c* in Fig. 2. It will be noted that the distortion indicated by the curve *c* is in an opposite direction to the distortion introduced by the transformer and indicated by the curve *b*.

In order to obtain the desired correcting distortion, the amplifier tube 30 is preferably of the exponential or variable μ type, the particular tube illustrated being an RCA-58. The tube includes a cathode 36, a control grid 37, a screen grid 38, a suppressor grid 39 and a plate 40. The input

circuit includes a grid resistor 41 and a biasing voltage source 42.

The output circuit of the tube 30 includes a plate resistor 43 having a resistance which is low compared with the plate impedance of the tube 30 whereby the grid volts-plate current characteristic of the tube has considerable curvature over a rather wide range of input voltage, as shown by the curve in Fig. 3.

The input circuit of the output tube 35 includes a grid resistor 44 and a biasing voltage source 46. The output circuit of the amplifier tube 30 is coupled to the input circuit of the output tube 35 through an inductor 47 and a coupling condenser 48, the inductor 47 being provided for the purpose of cutting off the higher frequency components of the saw-tooth voltage whereby resonant effects in the transformer 8 are avoided as described and claimed in my above-mentioned co-pending application.

The output tube 35 may be of the three electrode type having a cathode 49, a grid 51 and a plate 52. Its output circuit includes a choke coil 53 through which voltage is applied to the plate 52. The plate 52 is coupled to a point on the transformer winding through a coupling condenser 54 while the mid-point of the winding is connected to ground. It will be apparent that the primary of the transformer 8 is the portion of the winding between these two points.

The saw-tooth voltage impressed upon the input circuit of the amplifier tube 30 is of sufficient amplitude to swing the grid over the greater part of the tube characteristic shown in Fig. 3. The wave form of the voltage appearing in the output circuit of the tube 30 is indicated by the curve 56. This voltage appears in the output circuit of the output tube 35 with the wave form indicated by the curve 34, this being the wave shape desired for the voltage impressed upon the transformer 8.

The characteristic curve of the tube 30 may be given the desired curvature by adjusting the plate and screen grid voltages and by selecting the proper resistance for the plate resistor 43. It will be noted that the plate resistor has considerably lower resistance than that required for efficient amplification with a screen grid tube.

It may be noted that the saw-tooth voltage is applied to the output tube 35 in such phase that the sharp current reversal which is present in such a circuit occurs at minimum plate current in the output tube, it having been found that this is the condition for best operation.

The deflecting coil circuit shown in Fig. 4 may be substituted for the portion of the circuit in Fig. 1 shown to the right of the dotted line 60. It includes an extra amplifier stage 57, which is inserted for the purpose of reversing the phase of the voltage applied to the grid of the output tube, and an output tube 58.

The output tube 58 is preferably of the screen grid type, such as an RCA-2A5, which has such high plate impedance as compared to the impedance of the deflecting coils 59 that a saw-tooth voltage wave (one having no impulse component) impressed upon its grid 61 causes a flow of saw-tooth current through the deflecting coils. As previously explained, the deflecting coil characteristics are such that they cause the saw-tooth wave form of the deflecting current to be bent over whereby correction should be made in the same manner as when employing electrostatic deflection. The reason for inserting an extra amplifier is that the voltage applied to the

grid of the output tube 58 should be in such phase that during the return line period the output tube is driven close to cut-off whereby a high voltage appears across the deflecting coils and the return line period is made sufficiently short as compared with the deflecting period.

From the foregoing description it will be apparent that various modifications may be made in my invention without departing from the spirit and scope thereof and I desire therefore, that only such limitations should be impressed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. In combination, means for generating a saw-tooth voltage wave which consists of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of rapidly changing amplitude in the opposite direction which occurs during a return line period, an amplifier stage including an amplifier tube, an output tube, said means and said output tube being coupled through said amplifier stage, and a wave utilization network for producing a deflecting field to deflect a cathode ray, said network being coupled to said output tube and having the characteristic that it causes unavoidable distortion in a saw-tooth wave during its gradually changing and useful deflecting period, and said amplifier tube having a grid voltage-plate current characteristic which has the proper curvature to compensate for said distortion.

2. In a deflecting circuit for supplying a saw-tooth voltage to a pair of cathode ray tube deflecting plates, means for generating a voltage having a saw-tooth wave form, the voltage supplied to said deflecting plates and said generated voltage each consisting of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of rapidly changing amplitude in the opposite direction which occurs during a return line period, a transformer having a secondary connected across said plates, an amplifier stage including an amplifier tube, and means for supplying said generated voltage to said transformer through said amplifier stage, said transformer having the characteristic that it distorts the gradually changing portion of the saw-tooth voltage impressed thereon, said amplifier tube having a curved grid voltage-plate current characteristic, the curvature of said characteristic being such that it distorts the gradually changing portion of the saw-tooth voltage impressed thereon in a direction opposite and complementary to the distortion caused by said transformer.

3. The invention according to claim 2 characterized in that said amplifier comprises a tube of the pentode type, and further characterized in that the load impedance of the tube is low compared with its plate impedance.

4. In combination, means for generating a saw-tooth voltage wave which consists of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of rapidly changing amplitude in the opposite direction which occurs during a return line period, an amplifier having an input circuit and an output circuit, said amplifier including a vacuum tube, a cathode ray deflecting device coupled to said output circuit for producing saw-tooth deflection, means for impressing said saw-tooth voltage upon said in-

put circuit, said amplifier tube having a grid voltage-plate current characteristic which is curved sufficiently and in the right direction to so distort said first portion of the saw-tooth voltage wave that distortion of the saw-tooth deflection which would otherwise occur is prevented.

5. In combination, means for generating a saw-tooth voltage wave which consists of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of rapidly changing amplitude which occurs during a return line period, an amplifier having an input circuit and an output circuit, means for impressing said saw-tooth voltage upon said input circuit, said output circuit including a cathode ray deflecting device and a transformer through which a deflecting wave is supplied to said device, said output circuit causing an undesired distortion of said deflecting wave, an amplifier tube in said amplifier, said tube having a curved grid voltage-plate current characteristic, and means for operating said tube over such a portion of said curved characteristic that said first portion of the saw-tooth voltage wave is so distorted as to prevent said undesired distortion of said deflecting wave.

6. In combination, means for generating a saw-tooth voltage wave which consists of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of rapidly changing amplitude in the opposite direction which occurs during a return line period, an amplifier having an input circuit and an output circuit, said amplifier including a vacuum tube, means for impressing said saw-tooth voltage upon said input circuit, said output circuit including a cathode ray deflecting device for producing saw-tooth deflection, said output circuit causing an undesired bending over or distortion of the saw-tooth wave during the useful deflecting period, said amplifier tube having a grid voltage-plate current characteristic which is curved sufficiently and in the right direction to make said first portion of the saw-tooth voltage wave bend up in a complementary relation to the bending over of the wave in said output circuit whereby substantially straight line saw-tooth deflection is produced.

7. In combination, means for generating a saw-tooth voltage wave which consists of a portion of gradually changing amplitude in one direction which occurs during a useful deflecting period and a portion of a rapidly changing amplitude which occurs during a return line period, an amplifier having an input circuit and an output circuit, means for impressing said saw-tooth voltage upon said input circuit, said output circuit including a cathode ray deflecting coil through which it is desired to pass a saw-tooth current wave, said saw-tooth current wave having a gradually changing portion and a rapidly changing portion which correspond to the first and second portions of said saw-tooth voltage wave, said output circuit causing an undesired bending over of the gradually changing portion of said saw-tooth current wave, an amplifier tube in said amplifier, said tube having a curved grid voltage-plate current characteristic, and means for operating said tube over such a portion of said curved characteristic that said first portion of the saw-tooth voltage wave is bent upwardly to prevent said bending over of said saw-tooth current wave.

WILLIAM A. TOLSON.