United States Patent [19]

Miyoshi et al.

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[45] Feb. 11, 1975

[54] **FLYBACK TRANSFORMER APPARATUS**

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[73] Assignee: **Matsushita Electric Industrial Co., Ltd.,** Osaka, Japan

[22] Filed: **June 11, 1973**

[21] Appl. No.: **369,001**

[52] **U.S. Cl.** **315/411,** 336/94

[51] **Int. Cl.** **H01j 29/70**

[58] **Field of Search** .... 336/94, 198, 57; 315/27 TD, 27 XY, 28–29

[56] **References Cited**

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Primary Examiner—Maynard R. Wilbur
Assistant Examiner—J. M. Potenza
Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

A flyback transformer apparatus is provided in which a flyback transformer is provided with a first and second secondary winding with one end of the first secondary winding connected to at least one first rectifier and a second rectifier connected between one end of the second secondary winding and the other end of the first secondary winding, a capacitor is connected to the second secondary winding, and a primary winding of the flyback transformer is inductively coupled with the high-voltage side winding portion of the first secondary winding, whereby the output impedance is reduced and a focusing voltage which does not give rise to defocusing is provided.

7 Claims, 10 Drawing Figures

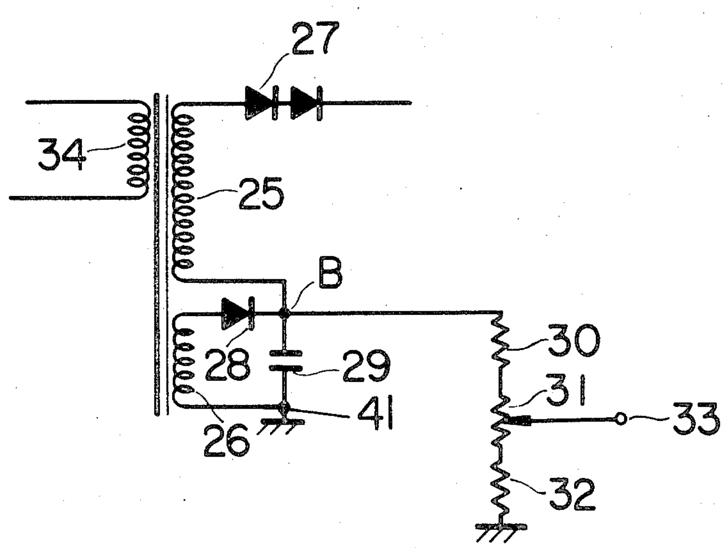


FIG. 1 PRIOR ART

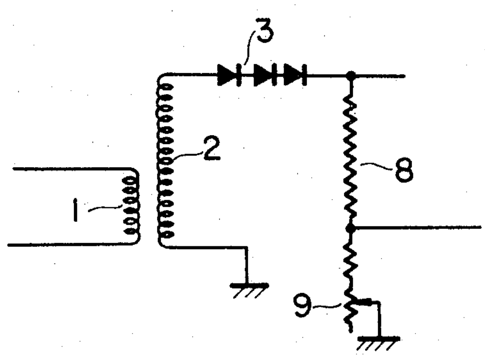


FIG. 2 PRIOR ART

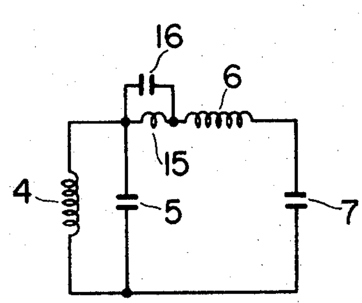


FIG. 3 PRIOR ART

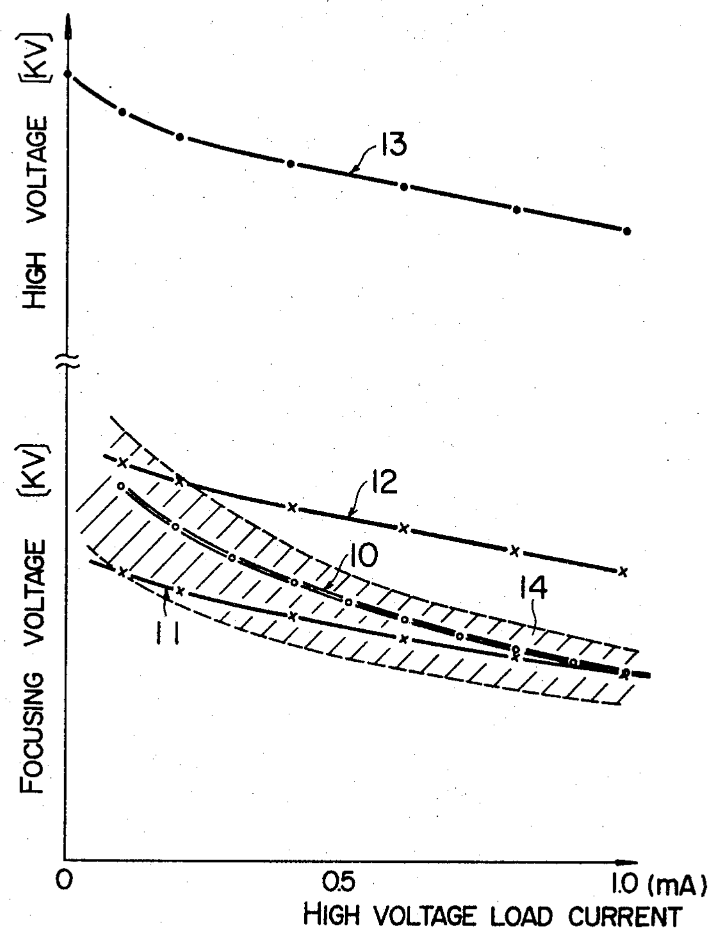


FIG. 4

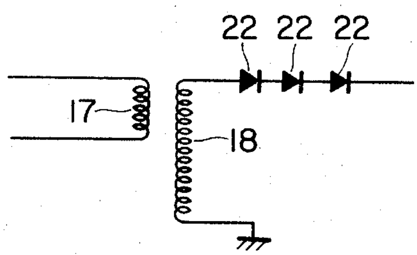


FIG. 5

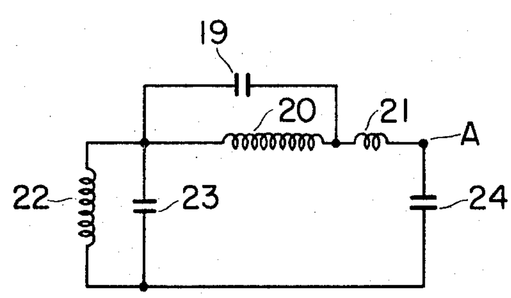


FIG. 6

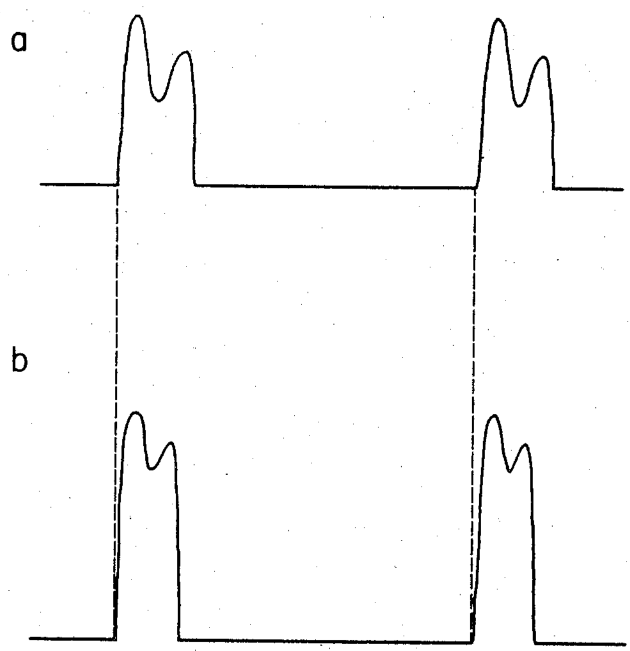
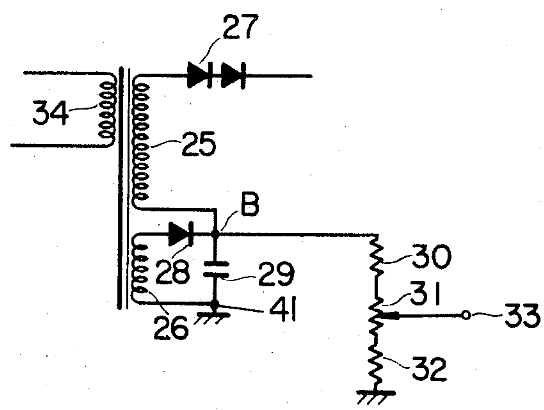


FIG. 7


27
34
25
B
30
31
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28
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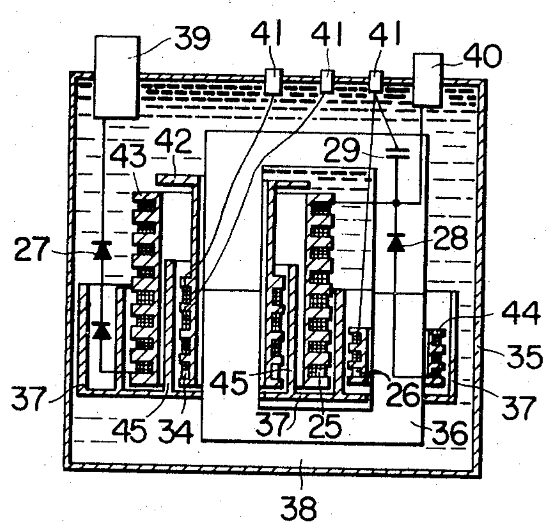
41
26
32

FIG. 8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45 34
37 25
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36
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FIG. 9

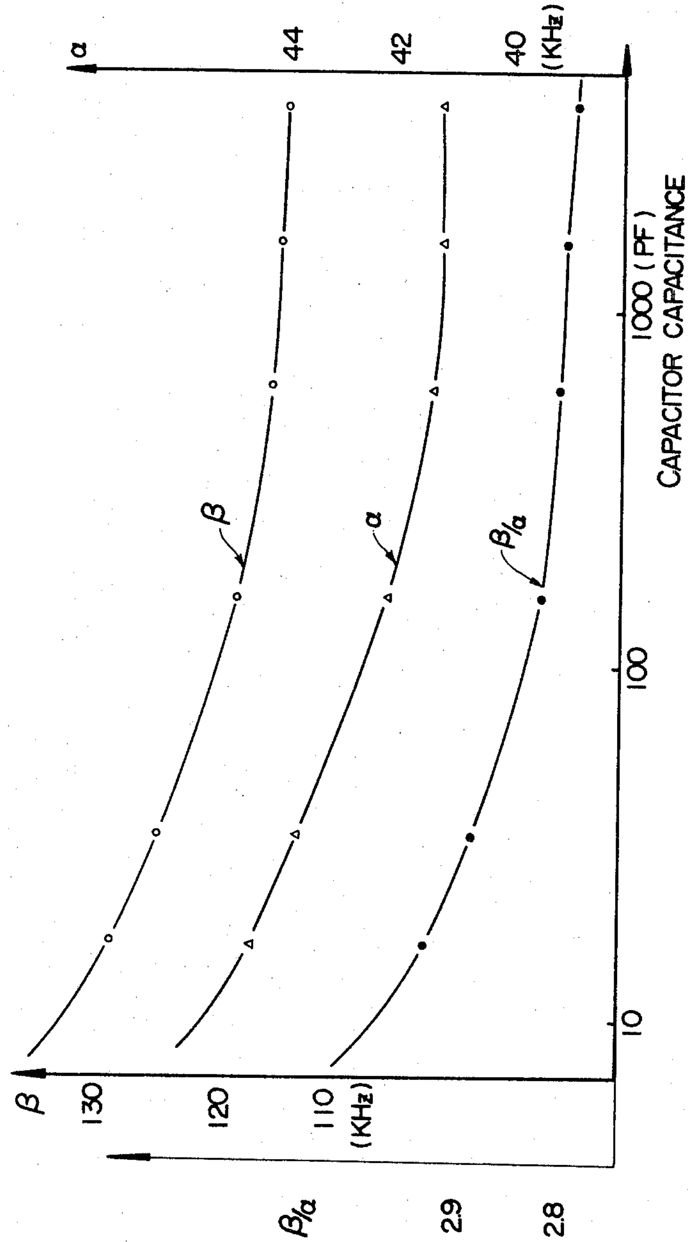
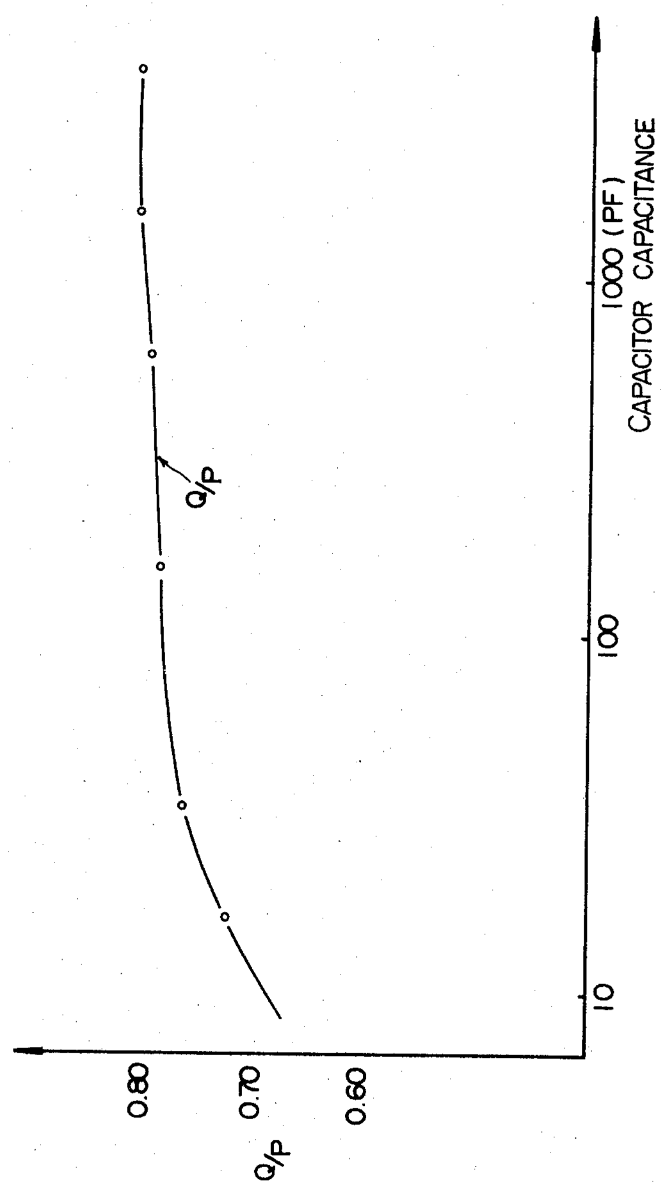

α
44
42
40
(KHz)
β
α
β/α
1000 (PF)
CAPACITOR CAPACITANCE
100
10
β
130
120
110
(KHz)
β/α
2.9
2.8

FIG. 10



FLYBACK TRANSFORMER APPARATUS

The present invention relates to improvements in flyback transformer apparatus for television receivers.

The flyback transformer apparatus according to the present invention will now be explained with reference to the accompanying drawings, in which:

FIG. **1** is a circuit diagram of a prior art flyback transformer apparatus for television receivers;

FIG. **2** is an equivalent circuit for the circuit of FIG. **1** transferred to the primary side;

FIG. **3** is a diagram showing examples of the focusing voltage curves in connection with the high voltage load current versus high D.C. voltage characteristic according to the circuit of FIG. **1**;

FIG. **4** is a circuit diagram of a flyback transformer apparatus useful for explaining a flyback transformer apparatus according to the present invention;

FIG. **5** is an equivalent circuit of the circuit shown in FIG. **4**;

FIG. **6** is a waveform diagram useful for explaining the circuit of FIG. **4**;

FIG. **7** is a circuit diagram of the flyback transformer apparatus according to an embodiment of the present invention;

FIG. **8** is a front sectional view showing a specific construction of the flyback transformer apparatus shown in FIG. **7**; and

FIGS. **9** and **10** are characteristic diagrams useful for explaining the flyback transformer apparatus according to the present invention.

Flyback transformer apparatus for television receivers are known in the art in which, as shown in FIG. **1** of the accompanying drawings, a primary winding **1** of a flyback transformer is disposed near the low-voltage side winding portion of a secondary winding **2** and a suitably selected higher harmonic tuning is effected. And rectifiers **3** are connected to the secondary winding **2** to produce the required high D.C. voltage. In such apparatus, the output impedance tends to become as high as 3.5 to 4.0 megohms so that the high D.C. voltage is changed with the high voltage load current and hence the amplitude of the picture on the cathode ray tube is changed. Thus, a drawback of such apparatus is that in order to stabilize the high D.C. voltage and eliminate variations in the amplitude of the picture, a high voltage control reactor is required in transistorized color television receivers, while a high voltage stabilizing tube is essential in vacuum-tube color television receivers.

On the other hand, in order to provide the required focusing voltage in a bipotential cathode ray tube, a high resistance resistor **8** is provided as shown in FIG. **1** so that the high D.C. voltage is divided to provide the required moderately high D.C. voltage. However, the use of the high resistance resistor **8** is disadvantageous, since a high power, highly voltage insulating, high resistance resistor must be used with resultant increase in the manufacturing cost and moreover the operation is not satisfactorily reliable. There is another drawback in that the moderately high D.C. voltage obtained is limited to one which has a fixed ratio to the high D.C. voltage and moreover the high impedance of the focusing circuit tends to cause defocusing even with a small amount of leakage current. In other words, when the high D.C. voltage is changed with the high voltage load current as shown by curve **13** in FIG. **3** of the accompanying drawings, if, in FIG. **1**, a variable resistor **9** is so adjusted that the optimum focusing is obtained when the high voltage load current of 1.0 mA is supplied, the resultant focusing voltage consists of a voltage represented by curve **11** in FIG. **3** and consequently defocusing will be caused when a high voltage load current lower than about 0.1 mA is supplied. Conversely, if the variable resistor **9** is adjusted so that the optimum focusing is achieved with the high voltage load current of 0.1 mA, a focusing voltage is produced which is represented by curve **12** and consequently defocusing occurs when the picture has high brightness. In FIG. **3**, curve **10** represents the optimum focusing voltage curve for the high D.C. voltage of the curve **13** and numeral **14** represents the allowable limits for the focusing voltage.

Further, when a doubler or tripler circuit is employed to rectify the pulse produced in the flyback transformer, voltage is taken from a portion of the rectifiers in the voltage-multiplier rectifying circuit and the required focusing voltage is provided through a low resistance resistor. A drawback of this type of apparatus is poor focus tracking. Further, while, in vacuum-tube color television receivers, the required focusing voltage is produced from the primary winding of the flyback transformer, a drawback of this method is that the high D.C. voltage must be stabilized by means of a high voltage stabilizing tube to ensure an improved focus tracking. The use of a high voltage stabilizing tube gives rise to such problems as the generation of heat by the tube and the radiation of X rays and therefore the resultant apparatus is not satisfactory.

FIG. **2** of the accompanying drawings is a simplified equivalent circuit of the circuit of FIG. **1** which has been transferred to the primary side. In FIG. **2**, numeral **4** designates the primary side inductance, **5** the primary side resonance capacitance, **6, 15** the leakage inductance transferred to the primary side, **7, 16** the secondary side resonance capacitances transferred to the primary side.

It is an object of the present invention to provide a flyback transformer apparatus which eliminates the foregoing deficiencies.

It is another object of the present invention to provide a flyback transformer apparatus which has a reduced output impedance, produces no defocusing and is capable of providing an improved focusing voltage.

It is another object of the present invention to provide a flyback transformer apparatus which provides the required high D.C. voltage output with a reduced output impedance.

It is another object of the present invention to provide a flyback transformer apparatus in which the distributed capacitance in the secondary winding is reduced and the third or higher harmonic tuning is simplified.

It is another object of the present invention to provide a D.C. superposition-type high voltage generator of the type in which the liquid insulation process is employed to simplify the insulation and wiring operations.

It is another object of the present invention to provide a high voltage generator of the type which employs an insulating separator means integrally formed with the concentric bobbins for primary and secondary windings to ensure a highly reliable insulation.

It is another object of the present invention to provide a flyback transformer which is capable of easily providing the desired moderately high D.C. voltage and effecting the optimum harmonic tuning.

It is another object of the present invention to provide a flyback transformer which is capable of easily effecting the optimum harmonic tuning to ensure the optimum focusing voltage characteristic for both bright and weak pictures.

It is another object of the present invention to provide a flyback transformer in which the secondary winding is provided with a dummy load to prevent an abrupt change in the high voltage output when a small load current is supplied.

In accordance with the present invention, there is provided a flyback transformer apparatus comprising a flyback transformer having a primary winding and a first and second secondary winding, at least one first rectifier connected to one end of the first secondary winding, a second rectifier connected between one end of the second secondary winding and the other end of the first secondary winding, and a capacitor connected to the second rectifier to store the voltage appearing thereacross, wherein the primary winding of the flyback transformer is inductively closely coupled with the high-tension side winding portion of the first secondary winding.

The preferred embodiment of this invention will be described with reference to the drawings.

For the sake of explanation, reference is made to a flyback transformer apparatus shown in FIG. **4**, wherein a primary winding **17** of a flyback transformer is disposed near the high-tension side winding portion of a secondary winding **18** so as to be inductively closely coupled therewith and a suitable harmonic tuning is effected. In comparison with the conventional circuit shown in FIGS. **1** and **2**, the line stray capacitance (designated as **19** in FIG. **5**) due to the primary winding **17** and the high-tension side winding of the secondary winding **18** is increased and at the same time it acts in parallel on an inductance **20** constituting a major portion of secondary side inductances **20** and **21** transferred to the primary side. Consequently, if the high voltage load is taken from a point A in FIG. **5**, the inductance is decreased as compared with that in the conventional circuit with a resultant decrease in the high output impedance. However, the increased line stray capacitance **19** results in an increased secondary side resonant energy so that the resonance in the primary which is practically determined by the primary inductance **22** and the primary resonance capacitance **23** is influenced by the resonance in the secondary. Consequently, a pulse voltage waveform as shown in FIG. **6*a*** is produced in the primary winding **17** with a more pronounced valley than in the pulse voltage waveform of FIG. **6*b*** produced in the primary winding **1** of FIG. **1** and at the same time the pulse width of the pulse voltage waveform produced in the primary winding **17** is increased due to the increased secondary resonance capacitance. Thus, there is a drawback in that the high voltage required for large cathode ray tubes used, for example, in 20-inch color television receiver cannot be generated and therefore the apparatus does not lend itself for practical use, though it attains a low impedance characteristic. In FIG. **5**, numeral **24** designates the secondary side resonance capacitance transferred to the primary side.

The foregoing difficulty is overcome by the circuit construction of the present invention shown in FIG. **7** of the accompanying drawings. In the circuit of FIG. **7**, the flyback transformer is provided with two secondary windings **25** and **26**, and first rectifiers **27** are connected to one end of the first secondary winding **25** and a second rectifier **28** is connected in the same sense as the first rectifiers **27** between the other end of the first secondary winding **25** and one end of the second secondary winding **26**. The other end of the secondary winding **26** is grounded. A junction point B of the rectifier **28** and the secondary winding **25** is grounded by way of a capacitor **29**. The point B is also grounded through a series circuit of a resistor **30**, variable resistor **31** and resistor **32**. The sliding terminal of the variable resistor **31** is provided with an input terminal for the focusing electrode of a cathode ray tube. A primary winding **34** of the flyback transformer is inductively closely coupled with the high-tension side winding of the secondary winding **25** rather than the low-tension side winding thereof.

With the arrangement described above, the D.C. voltage produced by the rectifier **28** is superimposed on the D.C. voltage produced by the rectifiers **27**, thereby providing the required high D.C. voltage for the cathode ray tube of a 20-inch color television receiver, for example. This arrangement is advantageous over that of FIG. **1** in that the pulse voltage induced in the first secondary winding may be lower than the pulse voltage induced in the secondary winding of the circuit shown in FIG. **1** and thus this arrangement is superior from an insulation point of view and there is less tendency for the occurrence of corona. Furthermore, the first secondary winding **25** is floated from the ground potential so that pulse voltages which are opposite in polarity to each other are generated at the ends of the first secondary winding **25**. Consequently, a moderately high D.C. voltage including no pulse component is generated at the midpoint of the first secondary winding **25**. The provision of the capacitor **29** also has the effect of shifting the midpoint to the side of the point B. As a result, the pulse voltage applied to the first secondary winding **25** is reduced with the result that the first secondary winding **25** is divided into two parts at the midpoint and thus the turn ratio between the primary and secondary windings is decreased, thereby reducing the distributed capacitance transferred to the primary side on the secondary side. Accordingly, it is possible to prevent an increase in the secondary side stray capacitance as in the arrangement of FIG. **4** and at the same time the circuit design for the third harmonic tuning or higher order harmonic tuning is simplified.

However, in a D.C. superposition type apparatus employing a dry type flyback transformer with high voltage windings consisting of a fine wire which has a diameter of the order of 0.1 mm, there is the danger of the high voltage winding breaking down or disconnection by electrolytic corrosion due to the moisture in the air and the moderately high D.C. voltage. However, this problem may be solved by employing a liquid insulation method which completely isolates the high voltage windings from the air and moisture. Further, the connections of the moderately high voltage lead wires may be placed in an insulating oil to thereby simplify the insulation treatment or the connecting operation. In addition, the immersion of the capacitor **29** in the insulating oil permits the use of lead wires having a lower line voltage proof as compared when the apparatus is used in the air and at the same time there is the effect of eliminating the mounting omission and erroneous use of different kind of wires during a repair work which may occur when the apparatus is mounted on the outside. Further, with the provision of the capacitor **29** in the flyback transformer in a television receiver employing a unipotential cathode ray tube, there is no need to use a terminal for moderately high voltage and hence the occurrence of a defect due to the breakdown of the terminal may be prevented.

On the other hand, in the flyback transformer for a 20-inch color television receiver, the proximity of the primary winding **34** and the first secondary winding **25** causes the application of a pulse voltage having a peak-to-peak value of about 30 kV. Therefore, if the apparatus is used in the air, an insulation gap of 20 to 30 mm is required thus making the flyback transformer bulky. In the illustrated embodiment of the present invention, however, the primary winding **34** is disposed close to the high-tension side winding portion of the first secondary winding **25** to reduce the high voltage output impedance and therefore the desired characteristics cannot be achieved if a gaseous insulation method is used with an insulation gap of 20 to 30 mm. Accordingly, this insulation problem can be solved by the use of a liquid insulation method.

FIG. **8** illustrates the flyback transformer apparatus of the invention hermetically housed in a sealed metal case filled with an insulating oil. In FIG. **8**, numeral **35** designates a sealed case, **36** a core, **37** a coil bobbin case mounted on the core **36**, **38** an insulating oil filled in the sealed case **35**, **39** a high voltage terminal, **40** a moderately high voltage terminal, **41** low voltage terminals, **42** a bobbin on which the primary winding **34** is wound, **43** a bobbin having the first secondary winding **25** wound thereon, **44** a bobbin having the second secondary winding **26** wound thereon, **45** an insulating separator formed integral with the coil bobbin case **37** and disposed between the bobbins **42** and **43**.

If it is intended to provide the insulation with the secondary winding bobbin **43** alone, the presence of defects such as welds or voids produced during the formation of the bobbin **43** may result in an insulation breakdown. For this reason, the insulating separator **45** is provided between the primary winding **34** and the first secondary winding **25** to provide a sufficiently high insulation. Further, since the insulating separator **45** is integrally molded with the coil bobbin case **37**, there is no increase in the number of assembly steps.

It is also possible to produce a moderately high D.C. voltage from the point B in the circuit shown in FIG. **7** and supply the required moderately high D.C. voltage to the bipotential cathode ray tube, thereby eliminating the need for the high resistance resistor **8** used in the apparatus of FIG. **1**. Further, since the point B (neutral point) changes its position dependent upon the capacitance of the capacitor **29**, the moderately high D.C. voltage appearing at the point B can be changed to thereby provide the desired moderately high D.C. voltage. Furthermore, since the interelectrode capacitance of the rectifier **28** is sufficiently small, it is equivalent as if the capacitor **29** were connected in series with the first secondary winding **25**. Accordingly, by changing the capacitance of the capacitor **29**, the secondary resonance capacitance in the equivalent circuit can be varied and hence the resonance frequencies α and β and the magnitude of the resonance Q/P can be changed as shown in FIGS. **9** and **10** where P is the magnitude of the resonance energy corresponding to the resonance frequency α and Q is the magnitude of the resonance energy corresponding to the resonance frequency β. Accordingly, the optimum harmonic tuning can be ensured for the flyback transformer depending on the capacitance of the capacitor **29** and it is thus possible to easily design a flyback transformer which operates efficiently. Further, by changing the capacitance of the capacitor **29** after the assembly of the flyback transformer, the higher harmonic resonance of the transformer can be adjusted and this is a very great advantage from the manufacturing point of view.

On the other hand, the second secondary winding **26** may be wound on the leg of the core **36** which is different from that for the first secondary winding **25** as shown in FIG. **8**, whereby the position of the second secondary winding **26** may be changed to change the higher harmonic tuning of the primary winding **34** and the second secondary winding **26**. Thus, it is possible to vary the slope of the focusing voltage for the high voltage load current and therefore the moderately high D.C. voltage can be made to correspond to the ideal focusing voltage value curve **10** shown in FIG. **3**. In this way, a flyback transformer can be produced which can provide the optimum focusing for both bright and weak pictures.

Further, the load current versus high D.C. voltage characteristic of the cathode ray tube is such that a steep curve is produced when the load current is very small or zero. With the flyback pulse, this means that a narrow pulse is superposed on the top portion thereof. With such a pulse, the high voltage drops abruptly upon the flow of a small load current. In this case, if resistors **30**, **31** and **32** are connected as a dummy load, current flows in the dummy load even under no load condition. Consequently, the high voltage is prevented from changing abruptly as mentioned earlier.

What we claim is:

1. A flyback transformer apparatus comprising: a flyback transformer having a primary winding, a first secondary winding and a second secondary winding; at least one first rectifier connected to one end of said first secondary winding; a second rectifier connected between one end of said second secondary winding and the other end of said first secondary winding; and a capacitor connected to said second rectifier in such a manner that said capacitor is charged up by a voltage produced across said second rectifier, wherein the entire primary winding of said flyback transformer is inductively closely coupled with the high-tension side winding portion of said first secondary winding.

2. A flyback transformer apparatus according to claim **1**, wherein said first rectifier is provided with a terminal from which a high D.C. voltage is taken, and said second rectifier is provided with a terminal from which a moderately high D.C. voltage is taken.

3. A flyback transformer apparatus according to claim **1**, wherein said primary winding and said first secondary winding are wound on one of two legs of a core, and said second secondary winding is wound on the other leg of said core.

4. A flyback transformer apparatus according to claim **1**, wherein said flyback transformer having said primary winding and said two secondary windings, said first and second rectifiers, and said capacitor are housed in a hermetically sealed case, and an insulating oil is filled in said case.

5. A flyback transformer apparatus according to claim **4,** wherein said primary winding and said first secondary winding are wound respectively on two bobbins concentrically mounted on said core, and an insulating separator is provided between said bobbins.

6. A flyback transformer apparatus according to claim **1,** further comprising a core having a first and second bobbin provided concentrically thereon, said primary winding wound on said first bobbin, said first secondary winding wound on said second bobbin, and said primary winding wound only on that portion of said first bobbin facing the high-tension winding portion of said first secondary winding.

7. A flyback transformer apparatus according to claim **1,** wherein a dummy load is connected between the junction point of said second rectifier and said first secondary winding and the ground.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,866,086

DATED : February 11, 1975

INVENTOR(S) : Keisuke Miyoshi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Please insert foreign application priority data as follows:

Date	Country	Number
June 28, 1972	Japan	65264/72
June 28, 1972	Japan	76891/72
June 28, 1972	Japan	76892/72
June 28, 1972	Japan	76893/72

Signed and Sealed this

Seventh Day of June 1977

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

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DATED : February 11, 1975

INVENTOR(S) : Keisuke Miyoshi et al.

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Signed and Sealed this

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