

July 13, 1937.

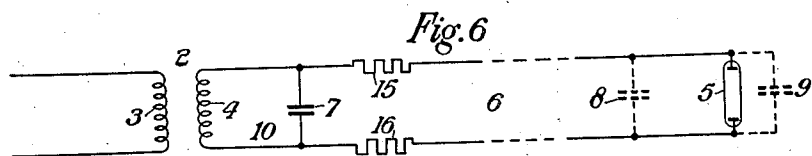
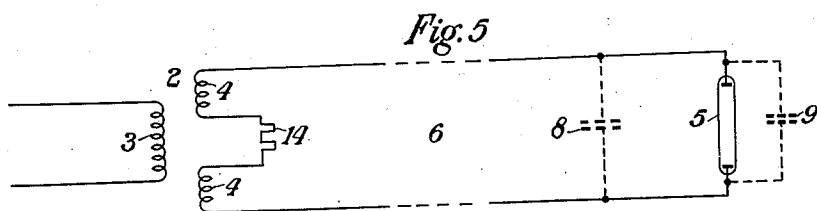
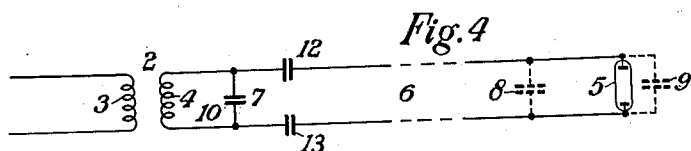
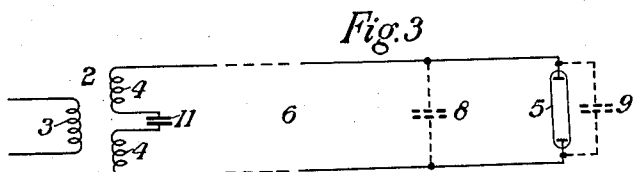
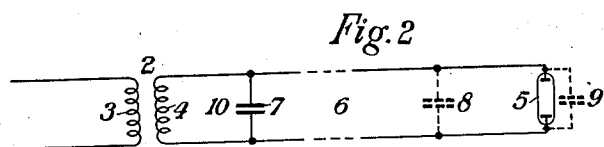
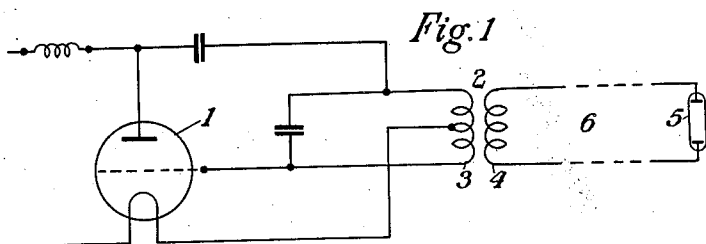
J. FODOR

2,086,668

APPARATUS FOR OPERATING ELECTRIC LUMINOUS TUBES

Filed July 25, 1934

3 Sheets-Sheet 1



INVENTOR

Joseph Fodor

July 13, 1937.

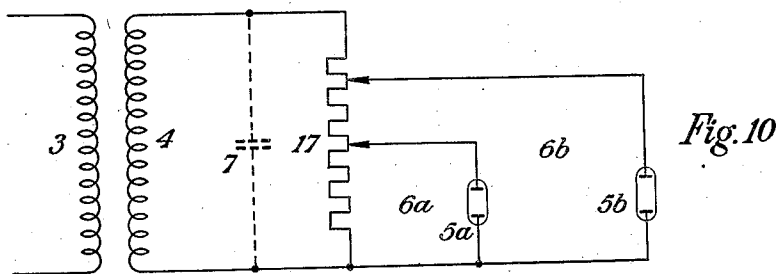
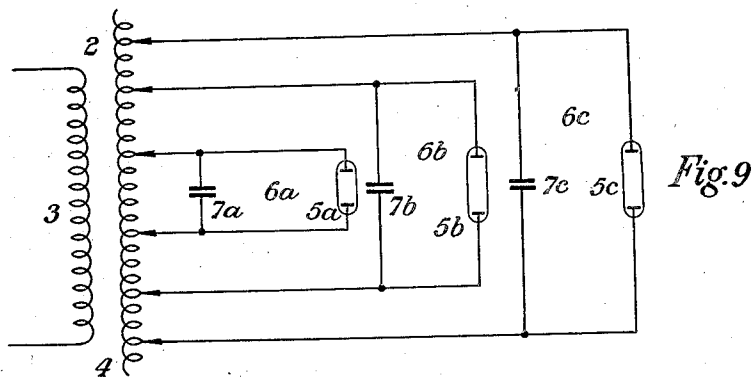
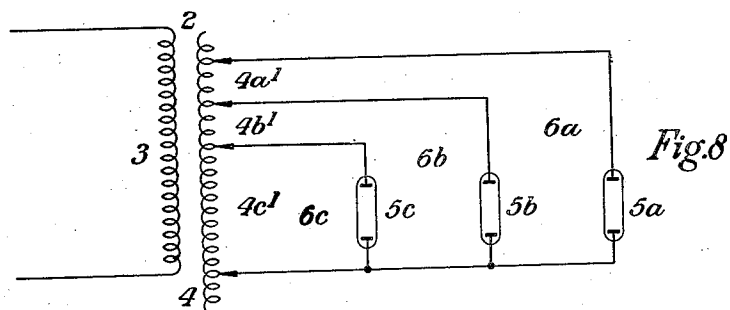
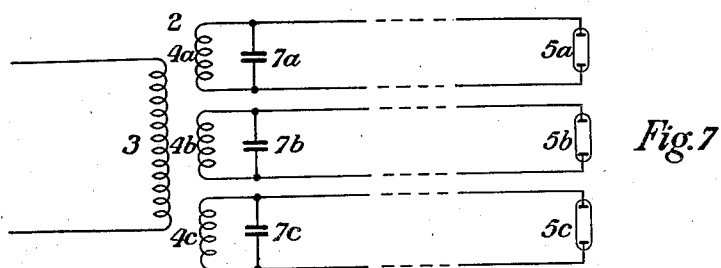
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2,086,668

APPARATUS FOR OPERATING ELECTRIC LUMINOUS TUBES

Filed July 25, 1934

3 Sheets-Sheet 2



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July 13, 1937.

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2,086,668

APPARATUS FOR OPERATING ELECTRIC LUMINOUS TUBES

Filed July 25, 1934

3 Sheets-Sheet 3

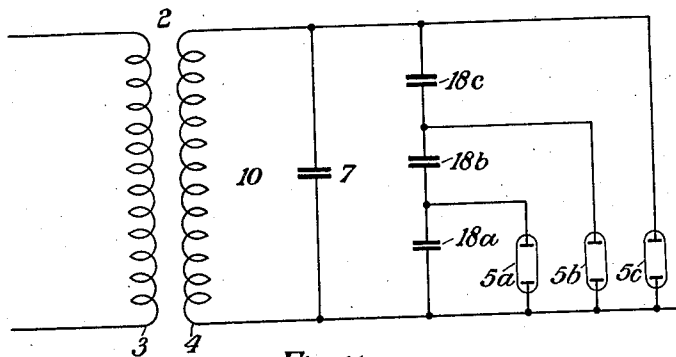


Fig. 11

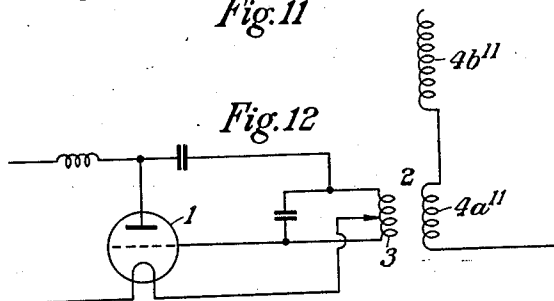


Fig. 12

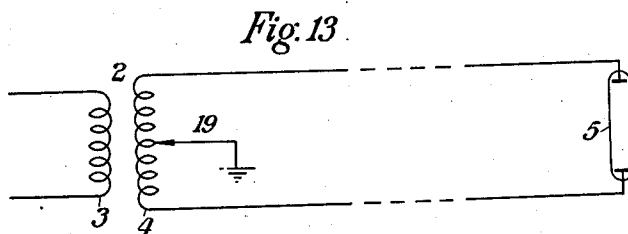


Fig. 13

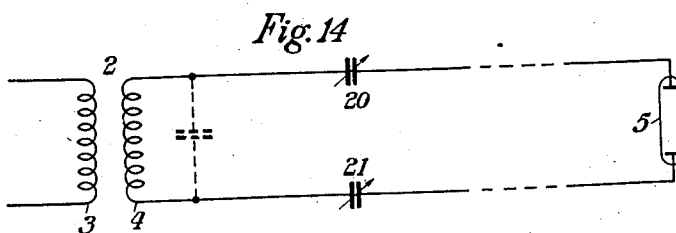


Fig. 14

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UNITED STATES PATENT OFFICE

2,086,668

APPARATUS FOR OPERATING ELECTRIC
LUMINOUS TUBES

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mesne assignments, of one-half to Victor Bec-
croft North, Kent, England

Application July 25, 1934, Serial No. 736,928
In Great Britain September 23, 1933

20 Claims. (Cl. 176—124)

This invention relates to apparatus for ener-
gizing one or more similar and/or different elec-
tric tubes with high frequency current to produce
a continuous or a varying lighting effect.

It is an object of this invention to provide
means whereby the harmful effect which capaci-
tive, inductive and resistive variation of the tube
circuits have upon the high frequency trans-
formation is eliminated. A further object is to
permit the apparatus to operate several and dif-
ferent tubes at the same time.

Another object of the invention is to avoid
disturbing reactions in the high frequency trans-
former of the system and a still further object
is to provide means whereby the tensions sup-
plied by the apparatus at the ends of the tubes
can be divided, at will, to suit operating require-
ments.

Apparatus according to the invention is char-
acterized by circuits having connected with them
means adapted to eliminate the effects of varia-
tions produced in the tube circuit or circuits by
external influences so as to permit tuned trans-
formation to be maintained. According to the
invention the variations in question are out-
weighed or rendered ineffective by means of suit-
able capacities, self-inductances or resistances
connected in parallel or in series with the second-
ary circuit of the high frequency transformer, or
by making the secondary and the tube circuits,
respectively aperiodic.

In order to operate several and different tubes
off the same apparatus at the same time, a high
frequency transformer is used, which has several
secondary circuits. Alternatively or addition-
ally, the secondary circuit or any or each of such
circuits, when there is more than one, is designed
as a capacitive, inductive or resistive potential
divider, thus providing for the tapping off of the
different tensions required by the different tubes.
In any case the apparatus includes suitable ar-
rangements for preventing undesirable effects
due to variations in the tube circuits as mentioned
hereinbefore.

The secondary side of the high frequency
transformer, when the higher tensions required
by the tubes are generated, sets up a disturbing
reaction upon the primary side of the said trans-
former and, consequently, upon the generator
itself but according to the present invention this
disturbance is avoided by dividing the secondary
side into several windings of which one only is
coupled to the primary side.

Owing to the asymmetry of the high frequency
transformer or the tube circuits, the tubes receive

different tensions at their ends. In order to
avoid this usually uneconomical method of feed-
ing, the high frequency transformer is earthed in
its symmetry-centre and/or coupling condensers
are introduced into each of the leads of the tube
circuits. Both these methods may, however, be
used in modified form to supply the ends of the
tubes with different, optional, or periodically
varying tensions.

This invention will now more particularly be
described with reference to the accompanying
drawings, in which:

Fig. 1 is a general circuit diagram illustrating
a valve generator operating an electric luminous
tube, the said tube itself and the high frequency
transformer connecting these latter.

Fig. 2 illustrates the elimination of the effects
of capacitive variations of the leads and the tubes
by means of a parallel condenser.

Fig. 3 illustrates the elimination of the effects
of capacitive variations of the leads and the tubes
by means of a series condenser.

Fig. 4 illustrates the elimination of the effects
of capacitive variations of the leads and the tubes
by both parallel and series condensers.

Fig. 5 illustrates how the circuit formed by the
high frequency transformer, the leads and the
tubes is made aperiodic.

Fig. 6 illustrates an arrangement in which, al-
though the secondary circuit of the high fre-
quency transformer is periodic the circuit formed
by the leads and tubes is aperiodic.

Fig. 7 illustrates a high frequency transformer
having several secondary windings, each feeding
a corresponding tube circuit.

Fig. 8 illustrates a high frequency transformer
with several tappings for the different tube
circuits.

Fig. 9 is a variation of Fig. 8.

Fig. 10 illustrates a high frequency transformer
in connection with a potential divider.

Fig. 11 illustrates a high frequency transformer
in connection with a capacitive potential divider.

Fig. 12 illustrates how to avoid the disturbing
reaction of the secondary side upon the primary
side of the high frequency transformer by divid-
ing the secondary winding into several parts in
such a manner that a loose coupling between the
primary and secondary windings is obtained.

Fig. 13 illustrates a method of obtaining tension
symmetry in a tube circuit.

Fig. 14 illustrates a capacitive method of com-
pensating a tube circuit with a view of obtaining
tension symmetry.

Although in the drawings the diagrammatic

representations of electric luminous tubes indicate tubes provided with internal electrodes, it is to be understood that the present invention is equally applicable to apparatus and circuits for the operation of so-called electrodeless luminous tubes, or such with external electrodes.

Fig. 1 of the drawings illustrates by way of example, a valve 1 arranged for operation as a high frequency generator. The oscillations produced by this valve are transferred to the tubes 5 by a high frequency transformer 2. This coupling device, on its primary side 3, is matched according to well known technical rules to the valve generator 1 and is, in the present case, identical with the oscillator windings of the oscillatory circuit for the valve generator although separate oscillator windings may be provided if desired. The secondary winding 4 of the transformer 2 is so dimensioned as, on the one hand, to produce the higher tension required to strike and operate the tubes 5 and, on the other hand, to satisfy technical requirements as regards coupling with a view to matching the circuit elements to obtain maximum efficiency. For this purpose, a frequency may be chosen for the generator 1 identical with the natural frequency of the oscillatory circuit or circuits 6 formed by the secondary side 4 of the coupling transformer 2 and the tube or tubes 5 connected thereto, or an harmonic relationship may be established between the generator frequency and the tube circuit frequency, the object, in either case, being to obtain tuned transformation.

It may easily happen that, owing to weather conditions or other influences, or if the tubes be exchanged or interchanged, variations occur in the electrical constants (self-inductance, capacity, resistance, etc.) of the tube or tubes 5 connected to the high frequency transformer 2 or in those of its leads which are indicated by the dotted lines in Fig. 1. Such variations, by altering the natural frequency of the oscillatory circuit 6, formed by the tubes, their leads and the high frequency transformer winding, would in order to maintain tuned transformation, necessitate continual adjustment of the valve generator. Similar adjustments would be necessary if the number or type of the tubes were altered or certain alterations made in their leads. Figs. 2 to 6 are diagrams showing examples of methods whereby, in accordance with the present invention, the necessity for making such adjustments is avoided.

Referring to Fig. 2, the secondary side 4 of the high frequency transformer 2 is, by the addition of a shunt capacity 7, made part of an independent oscillatory circuit 10. This capacity 7 is so large that, by comparison with it, the capacitive variations in the leads (as indicated in dotted lines at 8) and those in the tubes (as indicated in dotted lines at 9) become negligible. Thus these latter capacitive variations will, for all practical purposes, only influence the natural frequency of the oscillatory circuit 10 to a negligible extent, for which reason said circuit 10 will at all times continue to be fed with frequencies corresponding to its natural frequency, although the generator frequency is not varied.

In the circuit arrangement shown in Fig. 3 a capacity 11 is connected in series with the secondary winding 4 of the high frequency transformer 2, the value of such capacity 11 being smaller than the capacitive variations indicated by 8 and 9. This arrangement gives, in effect, substantially the same result as that shown in Fig. 2,

the natural frequency of the oscillatory circuit 6 remaining practically constant, notwithstanding capacitive variations in the tubes or in their leads. By suitably choosing the value of the series capacity 11 the natural wavelength of the circuit formed by the secondary side of the transformer 2, the leads and the tubes can be so shortened as to permit of operation of the tubes by short waves.

The common principle of the methods illustrated by Figs. 2 and 3 consists in this; that, in order to maintain the natural frequency of an oscillatory tube-feeding circuit practically constant, in spite of certain capacitive variations, such additional capacities are coupled (either in series or in parallel) to this oscillatory circuit, in accordance with well known rules of the techniques of high frequency, that, compared with the value of these latter, the said capacitive variations become negligible. On the same principle, the addition, in series or in parallel, of suitable self-inductances and resistances will result in eliminating the effects of inductive or resistive variations occurring in the tubes or in their leads. These methods can, in practice, be applied in combination in such a way as to render ineffective capacitive, inductive and resistive variations which themselves occur in combination.

Fig. 4 represents a variation of the methods shown by Figs. 2 and 3. The secondary side 4 of the high frequency transformer 2 is, by the addition of a capacity 7, designed as an independent oscillatory circuit 10. The capacities 12 and 13 which connect the oscillatory circuits 6 and 10, are so small that the capacitive variations indicated by 8 and 9 will not influence the natural frequency of the oscillatory circuit 10. By the suitable coupling of suitable self-inductances this method can also be used to outweigh inductive variations.

According to Fig. 5 the oscillatory circuit 6, formed by the secondary side 4 of the high frequency transformer 2 and the leads and tube 5, is for instance, by the introduction of a resistance 14 made aperiodic. In this case the aperiodicity is responsible for elimination of undesired effects due to capacitive, self-inductive and resistive variations occurring in the leads and in the tubes.

Fig. 6 shows a variation on the arrangement shown in Fig. 5. In this case, although the secondary side 4 of the high frequency transformer 2 is, by the addition of the capacity 7, made part of an independent oscillatory circuit 10, the circuit 6, formed by the leads and tubes, is made aperiodic, for instance, ohmically by the introduction of the resistances 15 and 16.

In order to operate several and, if necessary, different tubes off one and the same apparatus the secondary side of the high frequency transformer can be designed in any of the ways shown in Figs. 7 to 11.

According to Fig. 7 the high frequency transformer 2, though having only one primary winding, is provided with a plurality of secondary windings, 4^a, 4^b, 4^c, each of which feeds a separate tube or group of tubes, 5^a, 5^b, 5^c. The secondary sides, 4^a, 4^b, 4^c, are preferably all arranged to operate at one common natural frequency and, in order to counteract undesirable external influences, each is designed according to one or other of the methods illustrated by Figs. 2 to 6. This latter provision is exemplified in Fig. 7 by the capacities 7^a, 7^b, 7^c, the function of which has already been described

with reference to Fig. 2. It may happen that the different secondary sides are required to supply different tensions, owing to different types of tubes being connected to them. In such a case each of the secondary windings, 4^a, 4^b, 4^c, although having different numbers of turns, will be tuned by the capacities 7^a, 7^b, 7^c to a common frequency or, according to requirements, each or some of the secondary circuits may be detuned or, again, those secondary windings which are to supply a smaller tension may, according to the tension required, be tuned to one of the harmonics of the primary frequency.

According to Fig. 8 the secondary side 4 of the high frequency transformer 2 is constructed as a potential divider. The secondary winding has, for this purpose, a suitable number of tapings, 4^a, 4^b, 4^c, which permit not only of the suitable choice of the tensions required by the different tubes or groups of tubes, but also of the right selection of the values of the self-inductances influencing the natural frequency of the secondary circuits 6^a, 6^b, 6^c.

Fig. 9, which illustrates a variation of Fig. 8, shows how to apply one of the methods illustrated by Figs. 2 to 6, the one selected, by way of example, being that shown in Fig. 2. The large shunt capacities, 7^a, 7^b, 7^c, on the one hand, eliminate the effects of capacitive variations occurring in the circuits 6^a, 6^b, 6^c, and, on the other hand, permit the circuits connected to the various sections of transformer secondary winding to be tuned to a common frequency.

Fig. 10 represents the case of an ohmic potential divider. The secondary side 4 of the high frequency transformer 2 is here shunted by a resistance 17 which, in its turn, is tapped off according to the tensions required to operate the different tubes or groups of tubes. Fig. 11 represents the case of a capacitive potential divider. The secondary coil 4 of the high frequency transformer 2, having been made part of an oscillatory circuit 10 by the inclusion of the capacity 7, feeds a system of capacities, 18^a, 18^b, 18^c, connected in series. The values of these latter capacities can be chosen in accordance with the tensions required for the tubes 5^a, 5^b, 5^c.

In order to avoid disturbing reaction of the secondary side 4 of the high frequency transformer 2 on the primary side 3 thereof and thus to avoid the generation of distorted, for instance, double waves, according to Fig. 12 the secondary winding 4 is divided into several parts, such as; 4^a and 4^b, of which only one is coupled to the primary winding 3.

For the purpose of energizing the tubes at the highest grade of efficiency the secondary winding or windings of the high frequency transformer may, with advantage be furnished with means for correcting asymmetric distribution of tension caused by the tubes, their leads or their direct coupling elements or by any other influence in the tube feeding circuit or circuits. The object of this precaution is to ensure that the tubes receive equal tensions at both ends even though such tensions, may perhaps, differ in phase.

Fig. 13 illustrates one method of making the desired correction. In this particular case the secondary side 4 of the high frequency transformer 2 is earthed at its tension symmetry centre 19, which is to be distinguished from its geometric mid-point. Another method is illustrated by Fig. 14. Here the secondary side 4 of the high frequency transformer 2 feeds the tube 5 through

the adjustable capacities 20, 21, in which case the ends of the tubes 5 will receive higher or lower tensions according to the value of the said adjustable capacities.

The methods as illustrated by Figs. 13 and 14 can of course also be applied to the purpose of imparting a higher tension to one end of a tube or group of tubes, than to the other, or to the purpose of obtaining periodic variations of tension at the ends of the tubes. In this latter case the earthing connection as indicated in Fig. 13 is not established permanently at the tension symmetry centre 19 but is moved by some suitable means periodically along the winding or, according to Fig. 14 the values of the capacities 20, 21 are by some suitable means varied periodically.

I claim:

1. Apparatus for energizing an electric luminous tube comprising in combination a source of high frequency current, a transformer connected to said source of current, an electric luminous tube connected to the secondary winding of said transformer, and means associated with the secondary circuit to cause it to be made aperiodic.

2. Apparatus for energizing an electric luminous tube comprising in combination a source of high frequency current, a transformer connected to said source of current, an electric luminous tube connected to the secondary side of said transformer, tuning means associated with said secondary side, and means associated with the tube circuit coupled with the secondary oscillatory circuit for causing said tube circuit to be made aperiodic.

3. Apparatus for energizing electric luminous tubes comprising in combination a source of high frequency current, a transformer having a primary winding which is connected to said source of current, a plurality of secondary windings on said transformer, and an electric luminous discharge tube connected to each of said secondary windings.

4. Apparatus for energizing electric luminous tubes comprising in combination a source of high frequency current, a transformer having a primary winding which is connected to said source of current, a plurality of secondary windings on said transformer, an electric luminous tube connected to each of said secondary windings, said secondary windings having different numbers of turns so that the requisite voltages are applied to the corresponding tubes, and means associated with each of said secondary windings for tuning said secondary circuits to multiples of the frequency of the source of current.

5. Apparatus for energizing several and different electric luminous tubes comprising in combination a source of high frequency current, a transformer connected to said source of current, a potential divider associated with the secondary winding of said transformer including a plurality of tapings from which different voltages and if required different frequencies can be tapped, and a plurality of electric luminous tubes connected to corresponding points of the potential divider.

6. Apparatus for energizing an electric luminous tube comprising in combination a source of high frequency current, a transformer having a primary winding connected to said source of current, an electric luminous tube connected to the secondary side of said transformer, said secondary side being divided into several parts only one of which is coupled to the primary winding.

7. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirements of said electric luminous discharge device.

8. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices having different electrical characteristics, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirements of said electric luminous discharge device.

9. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary winding connected to be supplied from said source and a plurality of separate secondary windings and associated secondary circuits, each of said secondary circuits and associated secondary transformer windings being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirements of said electric luminous discharge device.

10. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary winding connected to be supplied from said source and a plurality of separate secondary windings and associated secondary circuits, said secondary windings having different numbers of turns in accordance with the different tensions required in the associated secondary circuits and each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency elec-

trical tension which is suited to the individual requirements of said electric luminous discharge device.

11. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, each of said secondary circuits being tuned to the same natural frequency and being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirements of said electric luminous discharge device.

12. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, at least one of said secondary circuits being tuned to a harmonic of the primary frequency in accordance with the tension requirements of said secondary circuit and each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of each of said circuits to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirements of said electric luminous discharge device.

13. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, at least two of said secondary circuits being tuned to different frequencies in accordance with the tension requirements of said secondary circuits, and each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of said circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirement of said electric luminous discharge device.

14. Electric luminous discharge apparatus, comprising in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side connected to said electric luminous discharge devices, and a potential divider associated with said secondary side of said transformer to provide a plurality of secondary circuits each of which is connected to an individual one of said

electric luminous discharge devices, whereby different tensions are tapped off on said secondary side of said transformer to energize said electric luminous discharge devices in accordance with the individual requirements thereof.

15. Electric luminous discharge apparatus, comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side connected to said electric luminous discharge devices, and an inductive potential divider associated with said secondary side of said transformer to provide a plurality of secondary circuits each of which is connected to an individual one of said electric luminous discharge devices, whereby different tensions are tapped off on said secondary side of said transformer to energize said electric luminous discharge devices in accordance with the individual requirements thereof.

16. Electric luminous discharge apparatus, comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side connected to said electric luminous discharge devices, and an ohmic potential divider associated with said secondary side of said transformer to provide a plurality of secondary circuits each of which is connected to an individual one of said electric luminous discharge devices, whereby different tensions are tapped off on said secondary side of said transformer to energize said electric luminous discharge devices in accordance with the individual requirements thereof.

17. Electric luminous discharge apparatus, comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side connected to said electric luminous discharge devices, and a capacitive potential divider associated with said secondary side of said transformer to provide a plurality of secondary circuits each of which is connected to the individual one of said electric luminous discharge devices, whereby different tensions are tapped

off on said secondary side of said transformer to energize said electric luminous discharge devices in accordance with the individual requirements thereof.

18. Electric luminous discharge apparatus comprising in combination a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, at least one of said electric luminous discharge devices being loosely coupled to its associated secondary circuit by a small capacity, and means including electrical impedance elements in each of said secondary circuits for adjusting the natural frequency of the corresponding circuit to supply the corresponding electric luminous discharge device with high frequency electrical tension which is suited to the individual requirement of said electric luminous discharge device.

19. Means for energizing a plurality of electric luminous discharge devices comprising, in combination, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits, each of said secondary circuits being connected to supply an individual electric luminous discharge device with high frequency electrical tension, at least one of said secondary circuits comprising means for rendering said secondary circuit aperiodic.

20. Electric luminous discharge apparatus comprising, in combination, a plurality of electric luminous discharge devices, a source of high frequency current, a high frequency transformer, said transformer having a primary side connected to be supplied from said source and a secondary side comprising a plurality of secondary circuits each of said secondary circuits being connected to supply an individual one of said electric luminous discharge devices with high frequency electrical tension, at least one of said secondary circuits comprising means for rendering said secondary circuit aperiodic.

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