May 13, 1947. H. DE FRANCE 2,420,303

STABLE FREQUENCY CONVERSION SYSTEM

Original Filed April 28, 1942 3 Sheets-Sheet 1

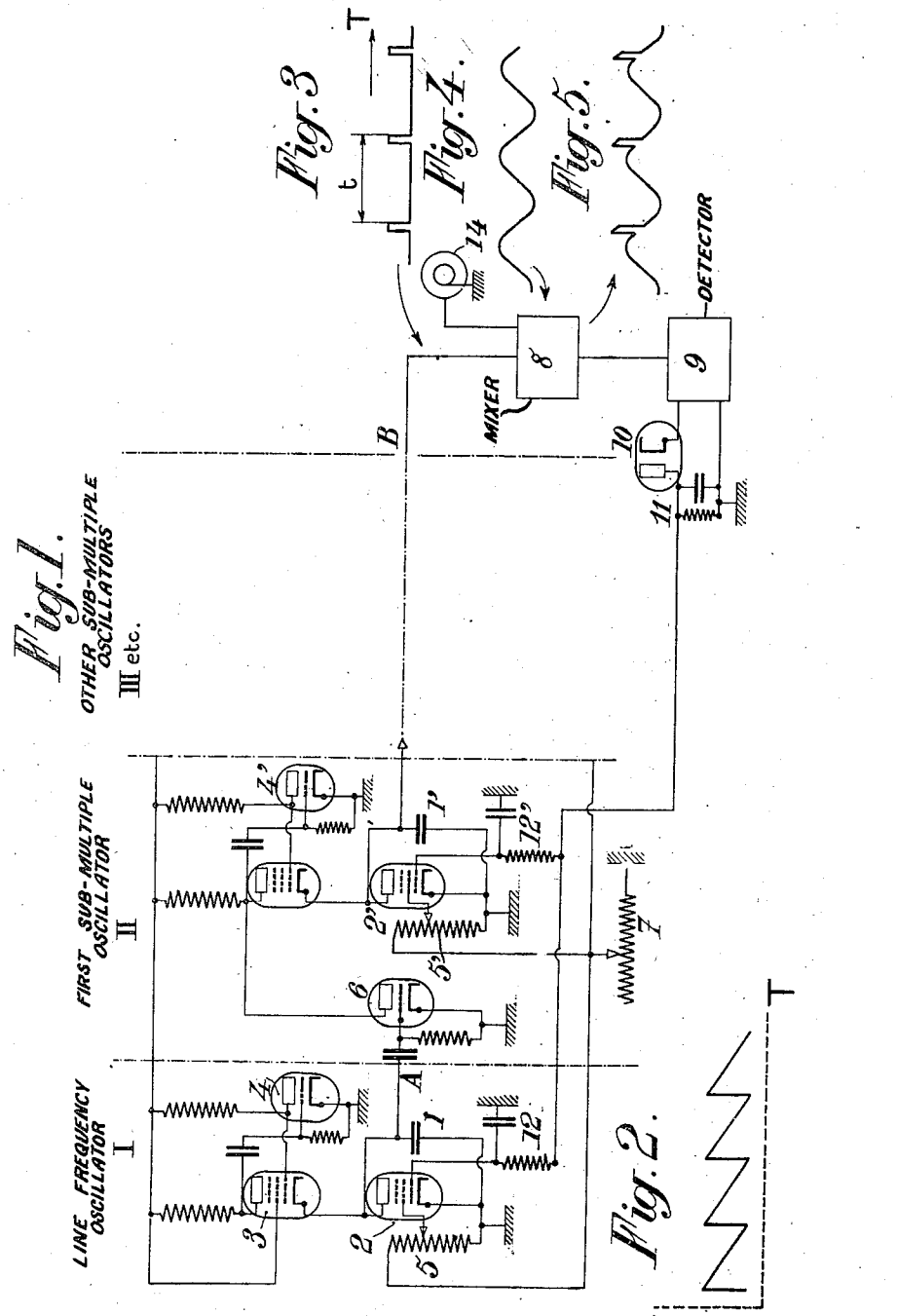

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Fig. 6.

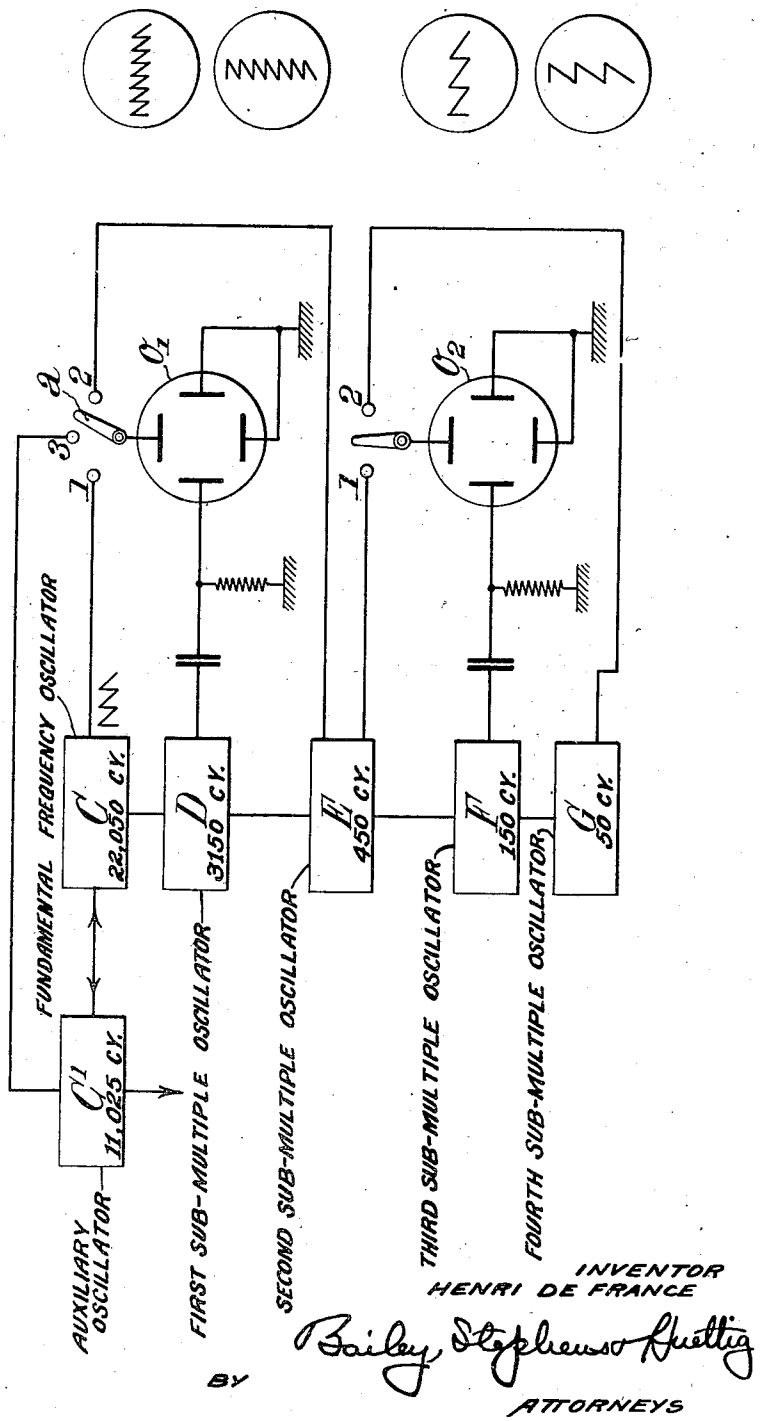

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Fig. 7.

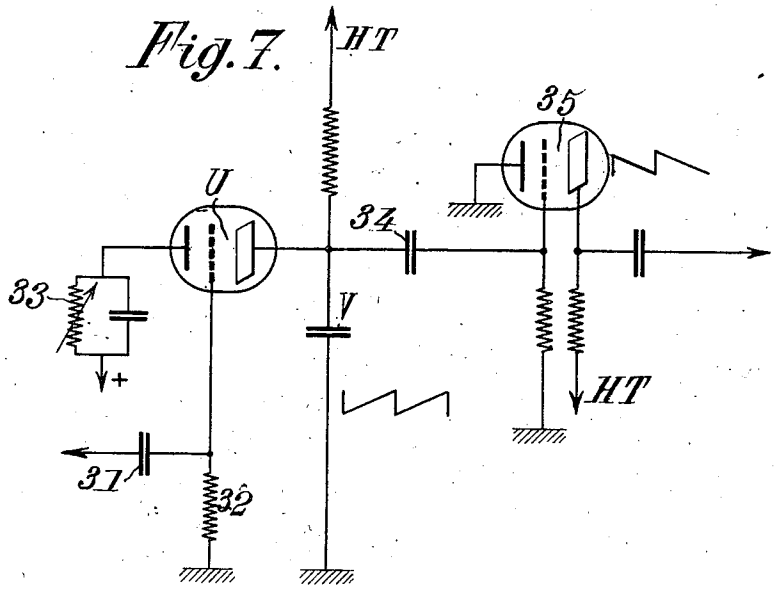
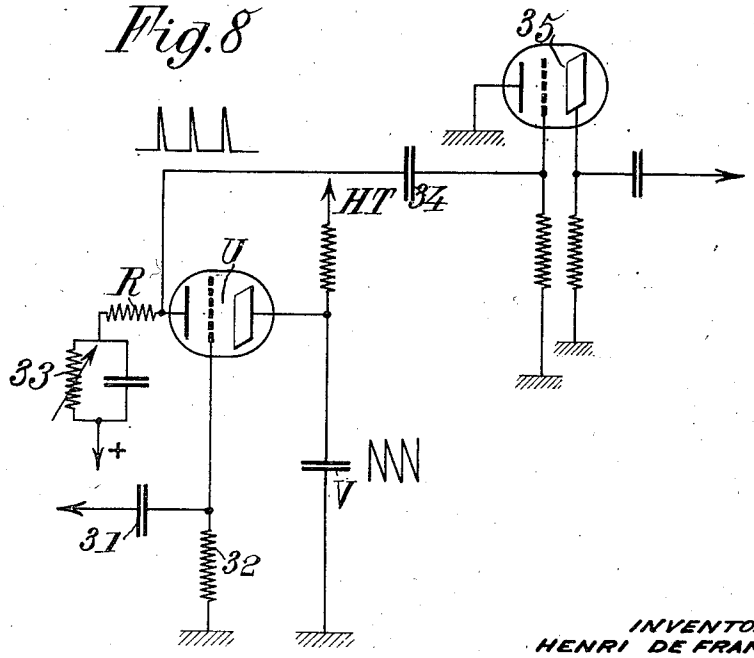


Fig. 8



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Patented May 13, 1947 2,420,303

UNITED STATES PATENT OFFICE

2,420,303

STABLE FREQUENCY CONVERSION SYSTEM

Henri de France, Lyon, Rhone, France; vested in the Attorney General of the United States

Continuation of application Serial No. 440,860, April 28, 1942. This application November 6, 1942, Serial No. 464,750. In France March 12, 1941

12 Claims. (Cl. 250—27)

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The present invention relates to oscillation generating systems for use in connection with television and like apparatus. The present application is a continuation of my prior application Serial No. 440,860, filed April 28, 1942.

An object of the invention is to provide oscillation generator systems, with means and methods for the adjustment thereof, which are especially, although not exclusively, applicable to apparatus for the transmission of television picture and line signals, such systems being more stable, and better adapted to meet the requirements of practice than those used for the same purpose up to the present time.

According to a feature of the present invention, in systems of the frequency demultiplier type, that is to say systems including a plurality of oscillators cooperating together so as to supply at least two utilization frequencies affording a given ratio of demultiplication or multiplication, I have recourse, in order to adjust the frequencies of the various oscillators, to means adapted to act simultaneously on those of their respective elements upon which the successive frequencies that are produced depend, in a manner to positively maintain the ratios of said frequencies, and, in particular, I impress perfectly determined and adjustable voltages upon said elements, for instance by means of a potentiometer common to the various oscillators.

According to another feature of the invention, pertinent to systems of the type above referred to, for producing at least one given frequency, especially those for television picture and line signals, I superimpose on this frequency a standard frequency (for instance that of an alternating current distribution system), and I cause the resultant frequency to react (preferably after detection) on the elements of said system upon which depends the frequency to be produced.

Another object of the present invention is the provision of a frequency demultiplier or multiplier which maintains the frequency conversion ratio in a more accurate manner than in the systems used for the same purpose up to the present time.

With this last mentioned object in view, according to a feature of my invention, I have recourse to a series of oscillators connected to one another according to multiples or sub-multiples of the fundamental frequency, their oscillations being preferably of the saw teeth type in order to increase the accuracy of the synchronism, and I combine with such an assembly means for controlling the frequency conversion ratio, such

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means including at least one oscillograph whose series of plates can be coupled at will selectively with at least two of the oscillators, in a manner to render visible the synchronism, according to the appearance of the resultant curve.

Other features of the present invention will be evident from the following detailed description and the drawings wherein preferred embodiments of the invention are given by way of example.

Fig. 1 is a diagram of a system for the transmission of synchronisation signals for television, according to the invention;

Fig. 2 is a curve illustrating the saw-tooth voltage supplied by the first stage of the system of Fig. 1 and the frequency of which is to correspond to that of the line signals;

Fig. 3 is a curve similar to that of Fig. 1 illustrating the production of the picture synchronizing signals obtained at the output end of the systems;

Fig. 4 is a curve illustrating the voltage of an alternating current distribution system to be superimposed, according to a feature of the invention, on the picture synchronizing signals produced by a system of the kind of Fig. 1;

Fig. 5 is a similar curve illustrating the result of this superimposition of voltages;

Fig. 6 diagrammatically shows the whole of a line and picture frequency generating system for use in television, and of a device for the control of the frequencies, according to the invention;

Fig. 7 diagrammatically shows the relaxation tubes which can advantageously be used in such a combined system according to the present invention;

Fig. 8 is a view, similar to Fig. 7, showing similar tubes made according to a modification.

I will first describe a system according to the invention for the production of oscillations for transmitting synchronizing signals (corresponding to pictures and lines) for television.

It is known in the art to make use, for this transmission, of a series of multivibrators or relaxation oscillators the first of which supplies the frequency which is to correspond to the scanning of the lines (for instance $441 \times 50 = 22050$, if it is desired to obtain 441 lines in each picture and 50 pictures per second) while the others are synchronized to frequencies which are sub-multiples of the first, so as finally to supply the frequency of the picture synchronizing signals, to wit 50 per second.

For instance, in a given arrangement, the system includes, after the first oscillator, tuned to the frequency of 22,050 per second, four oscil-

lators respectively synchronized to the following frequencies:

$$\frac{22050}{7}=3150;\ \frac{3150}{7}=450;\ \frac{450}{3}=150;\ \text{and}\ \frac{150}{3}=50$$

However, this kind of arrangement involves disadvantages. In particular, if the frequency of the first oscillator varies by a value equal to 1/7 of its value, due for instance to a voltage adjustment, the second oscillator suddenly ceases to correspond to the sub-harmonic of order 7 so as to correspond to the adjacent sub-harmonic of order 6 or 8, whereby the scanning is wholly modified.

In order to obviate these drawbacks, according to the invention the respective oscillators are caused to coact with regulating means such that they positively maintain the ratios between the successive frequencies.

For instance, if the frequency of each of said oscillators depends upon the discharge speed of a condenser, as is the case with oscillators or multi-vibrators of the relaxation type, this speed being itself a function of a voltage impressed, for instance, upon one of the electrodes of the tube or of one of the tubes of the corresponding oscillator, the regulating will consist in regulating the above mentioned voltages of the respective oscillators from a common device, such for instance as a potentiometer.

It goes without saying that such a result can be obtained in many different manners depending in particular upon the nature of the oscillators that are utilized.

In Fig. 1, I have shown a group of multivibrators or relaxation oscillators, of known types, the first two oscillators only being shown on the drawing.

Compartment I contains the main oscillator. Condenser 1 discharges slowly into pentode tube 2, and it is charged suddenly through tube 3 during the short time for which the latter is not fully blocked by its polarization. An auxiliary tube 4 may be provided, in known manner, for accelerating the beginning of the charge. Finally, the discharge speed, which determines the frequency, is initially regulated through any known means, for instance by adjusting the screen voltage of tube 2, which determines the value of the plate current. This adjustment is effected by means of a potentiometer 5 or through any other means.

Finally, I obtain, at the output end of the first compartment, at A, a voltage which has, for instance, the saw-tooth shape illustrated by Fig. 2 and which is utilized for the line synchronizing signals, its frequency having been suitably adjusted for this purpose.

Compartment II, which is connected to the first compartment through a capacity or other coupling, includes elements 1', 2', 3', 4', similar to those of the first compartment. However, the capacity of condenser 1' is greater in such manner as to supply a lower frequency, with the demultiplication ratio that has been chosen. Furthermore, in order to transmit the voltage of compartment I, there are provided means such as a tube 6 or the like for ensuring synchronizing, by frequency demultiplication, of compartment II with compartment I.

Compartments III, IV, etc., in turn supply demultiplied frequencies. The last one produces, at its output end, at B, a voltage at the frequency of the picture synchronizing signals, for instance 50 per second and in a form illustrated by the curve of Fig. 3.

Such a system having been provided, it is then combined, as above stated, with a common adjustment potentiometer, through which the individual potentiometers 5, 5', etc. are fed, instead of having them controlled, in the usual manner, by the high frequency of the station.

It will be readily understood that with this adjustment common to the various compartments, it is possible simultaneously to vary the respective discharge of condensers 1, 1', etc., by proportional amounts, which also ensures proportional displacements of all the intermediate frequencies of the system.

Thus is ensured the maintaining of the ratio of the extreme frequencies, but it should be well understood that all other assemblies giving the desired result might be employed according to the invention.

With such a system as described above there can be advantageously used other features such as the following, which can be employed separately if desired.

According to one of these features, which will be supposed to be applied to a system of the type above described, I have recourse, for stabilizing the frequencies generated by said system, to means utilizing the superimposition of a standard frequency for reacting, in a suitable manner, upon the elements upon which depend the value of said frequencies.

Thus, considering the voltage of the picture synchronizing signals, obtained at the output end of the system at B, which, in the example that has been chosen, varies at a frequency which is supposed to be of 50 periods,

a. there is imposed on to this voltage, by means of a suitable mixing device 8 of a known type, the alternating sinusoidal voltage of a distribution system 14 of 50 periods frequency (Fig. 4), this superposition giving rise to a combined voltage as illustrated by Fig. 5;

b. there is effected, through any suitable means, a detection of the tops of the curve of this resultant voltage in such a way that a constant rectified continuous voltage is produced, if both of the component frequencies remain the same, while a variable voltage is produced if dephasings take place due to variations between these two frequencies, and

c. the voltage that is obtained is caused to act upon at least one of the compartments I, II, etc., or upon each of these compartments, through one of the elements upon which the frequency depends, for instance the control grids of tubes 1, 1', etc., as shown by the drawing.

In the example illustrated by the drawing, detector 9 includes a diode tube 10 and the negative rectified voltage 11 is utilized for polarizing the control grids, with suitable couplings shown at 12, 12', etc., the whole being arranged in such manner that an effect is produced upon the discharge speed of condensers 1, 1', etc., in a correcting direction, that is to say in such manner as to bring the final frequency of signal B to a value equal to that of the distribution system.

In order to obtain this result, if the signals succeed one another at time intervals shorter than desired, the discharge speed of I is reduced, by producing increased polarization of tube 2 corresponding to an increase in the absolute value of negative voltage 11. Examination of Fig. 5 shows that this is what takes place when the signals tend to move toward the left, since the maximum ordinate of their tops then tends to increase.

It is known that, in a television system, it is necessary to obtain a very sharp synchronism relation between the two extreme frequencies, that is, the frequency of the lines and the frequency of the pictures, the second of which must be, very accurately, a sub-multiple of the first. Accuracy of synchronism is especially important with the interlacing method, the efficiency of which is wholly nullified if the end of a picture, for instance, is not obtained for exactly the same position of a line of a given number.

According to a feature of the present invention, in order to obtain the desired synchronism, the whole of the oscillator system is first arranged in such manner as to include a fundamental generator coupled with a series of generators of proper sub-multiple frequencies, which are interrelated to one another, as above described.

These generators are preferably such that they supply a saw-tooth curve, because such an arrangement permits of increasing the accuracy and the stability of the interrelation between the generators, and therefore the synchronism.

It suffices to utilize for this purpose any known device, of the relaxation or other type, with ordinary tubes mounted as multivibrators or thyratrons.

If for example, it be desired to obtain, in the interlacing method, an analysis corresponding to 441 lines and 50 half pictures per second (therefore 25 complete pictures per second) I may make use of a fundamental generator C (Fig. 6) giving a frequency of:

$$f=441\times 50=22{,}050 \text{ cycles}$$

and to which are successively connected generators D, E, F, G; giving the following sub-multiple frequencies:

$$\frac{22050}{7}=3150$$

$$\frac{3150}{7}=450$$

$$\frac{450}{3}=150$$

$$\frac{150}{3}=50$$

the last one giving the picture frequency.

Instead of making use of a fundamental generator of a frequency equal to f, I might make use of another generator of different frequency, for instance

$$\frac{f}{2}$$

as shown at C' on Fig. 6.

In Figs. 7 and 8, I have shown, merely by way of example, two mountings involving to the use of thyratrons.

According to the embodiments of Fig. 7, the synchronizing signals coming from the preceding generator are applied to the grid of thyratron U through a condenser 31. The leak resistance is shown at 32 and the adjustable resistance at 33. The plate of the thyratron which is connected with high voltage HT through an adjustable resistance, returns to the ground through a condenser V. The cathode circuit is positively polarized. The saw-tooth signals coming from said plate (and diagrammatically shown on the drawing) are then transmitted through a condenser 34 to the grid of a tube 35 which feeds, with the usual phase difference of 180°, a saw-tooth current (also shown in the drawing). These signals are finally transmitted to the next generator and so on.

Fig. 8 shows an analogous system in which the same reference numerals designate the same elements. The only difference lies in the fact that the signals, indicated on the drawing, result from the practically instantaneous charge and discharge of cathode U. By using preferably in the cathode circuit a resistance R, I obtain in said circuit very short signals (top of Fig. 8) corresponding to the successive discharges of condenser V. These signals are utilized for synchronizing the next generator.

Such systems produce saw-tooth curves of very sharp shape which are well adapted to the desired purpose.

With a series of such generators or any analogous arrangement, I combine means for checking the accuracy of the synchronism, that is to say the demultiplication, which means are constituted by at least one cathode oscillograph whose plates or series of plates may be coupled at will with at least two of the various generators. I can thus render visible the synchronism that is obtained, in accordance with the aspect of the resultant curve shown in said oscillograph.

For instance, considering such an oscillograph O^1 (Fig. 6) and supposing (also by way of example) that two of the plates of said oscillograph are grounded, it will be seen that if the two other plates are respectively connected to generators C and D, I obtain on the screen of the oscillograph a Lissajou curve which, when the demultiplication

$$\frac{1}{7}$$

is ensured in an exact manner, must be constituted by seven teeth, for instance, in the horizontal direction (that is to say with sharp vertical ridges).

If now, without modifying the connection between generator D and the corresponding deviating plate, I connect the other plate to generator E, I must obtain, under the same conditions, a resultant curve having seven teeth, in the vertical direction.

Of course, it is advantageous, in order to permit of working quickly, to make use of a switch such as a, including a suitable number of contact points, for instance three, if it is desired to be able to check the synchronism between C and C', when a generator such as C' has been provided.

The same checking operation can be performed with the following generators such as E, F, G, and this either with another oscillograph O^2 as shown, or by means of the same oscillograph O^1 associated with the switch a including a suitable number of contact points.

In any case, whatever may be the particular embodiment that is finally chosen, I obtain a system whose operation is sufficiently clear from the foregoing disclosure to make it unnecessary to enter into further details.

This system compared with prior systems used for the same purpose, has the following advantages:

(a) It ensures an easy, quick and very exact checking of the demultiplication ratio, that is to say of the synchronism; and

(b) It renders that synchronism more effective, owing to the saw-tooth shape of the oscillations, which permits of connecting the various generators with one another in a safe manner.

Of course, I may utilize supplementary synchronizing means, for instance such as described in Figs. 1 to 6.

In general, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto since changes can be made in the arrangement, disposition and form of the parts without departing from the principle of the present invention.

What I claim is:

1. A system for generating oscillations, especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a potentiometer determining the frequency of the oscillations produced by such device, coupling means interconnecting said oscillator devices so that the frequency of one depends upon the frequency of the other, and a common potentiometer for applying a potential simultaneously to the potentiometers of the oscillator devices to simultaneously regulate the frequencies of said oscillator devices, and thereby positively maintain the desired ratio of said frequencies.

2. A system for generating oscillations, especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including an element determining the frequency of the oscillations produced by such device, means interconnecting said oscillator devices so that the frequency of one depends upon the frequency of the other, a common means for applying a potential simultaneously to said elements of the oscillator devices to simultaneously regulate the frequencies of said oscillator devices, and thereby positively maintain the desired ratio of said frequencies, means for superimposing a standard alternating voltage on the voltage obtained at the output of the final oscillator device, means for detecting the tops of the curve corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one of said oscillator devices.

3. A system for generating oscillations, especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including an element determining the frequency of the oscillations produced by such device, coupling means interconnecting said oscillator devices so that the frequency of one depends upon the frequency of the other, a common potentiometer simultaneously applying a potential to said elements of the oscillator devices to simultaneously, regulate the frequencies of said oscillator devices, and thereby positively to maintain the desired ratio of said frequencies, means for superimposing a standard alternating voltage on the voltage obtained at the output of the final oscillator device, means for detecting the tops of the curve corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one of said oscillator devices.

4. A system for generating oscillations, especially intended for television, which comprises, in combination at least two oscillator devices, each oscillator device including a poteniometer determining the frequency of the oscillations produced by such device, coupling means interconnecting said oscillator devices so that the frequency of one depends upon the frequency of the other, a common potentiometer for applying a potential simultaneously to said potentiometers of the oscillator devices to simultaneously regulate the frequencies of said oscillator devices, and thereby positively maintain the desired ratio of said frequencies, means for superimposing a standard alternating voltage on the output of final oscillator device, means for detecting the tops of the curve corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one of said oscillator devices.

5. A system for generating oscillations especially intended for television, which comprises, in combination at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to slowly discharge through the first-mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected in a manner to accelerate the beginning of the charge of the condenser, and adjusting means connected with the screen of the first mentioned tube for adjusting the screen voltage thereof, so as to determine the plate current thereof, means for coupling the oscillator devices, the respective condensers of the oscillator devices being of different capacities so as to obtain the desired ratio of frequencies of said oscillator devices, means for transmitting the voltage from one of the oscillator devices to the other, and a single means for feeding a potential to said means for adjusting the screen voltages of the first mentioned tubes of said oscillator devices.

6. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to slowly discharge through the first-mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected in a manner to accelerate the beginning of the charge of the condenser, potentiometers connected with the screen of each of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, coupling means for connecting the first oscillator device with the second, the condensers of these oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, means for transmitting the voltage from the first oscillator device to the second, and a single adjustable means for feeding the potentiometers for adjusting the screen voltages of the first mentioned tubes of said oscillator devices.

7. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to slowly discharge through the first mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary

tube connected to accelerate the beginning of the charge of the condenser, potentiometers connected with the screen of each of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, coupling means for connecting one of the oscillator devices with the other, the respective condensers of these oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, means for transmitting the voltage from the one oscillator device to the other, and a single potentiometer for feeding the potentiometers for adjusting the screen voltages of the first mentioned tubes of said oscillator devices.

8. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to discharge through the first mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected to accelerate the beginning of the charge of the condensers, a potentiometer connected with the screens of each of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, capacities for coupling the first oscillator device with the second, the respective condensers of the oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, a tube for transmitting the voltage from the first oscillator device to the second, and a single potentiometer for feeding a potential to the potentiometers provided for adjusting the screen voltages of the first mentioned tubes of said oscillator devices.

9. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to discharge through the first mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected to accelerate the beginning of the charge of the condensers, adjusting means connected with the screens of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, coupling means for connecting the first oscillator device with the second, the respective condensers of these oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, means for transmitting the voltage from the first oscillator device to the second, a single means for feeding a potential to the means provided for adjusting the screen voltages of the first mentioned tubes of said oscillator devices, means for superimposing a standard alternating voltage on the output of the final oscillator device, means for detecting the tops of the curves corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one component of the oscillator devices.

10. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to discharge through the first mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected to accelerate the beginning of the charge of the condenser, potentiometers connected with the screens of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, coupling means for connecting one of the oscillator devices with the other, the respective condensers of these oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, means for transmitting the voltage from one oscillator device to the other, a single means for feeding the potentiometers provided for adjusting the screen voltages of the first mentioned tubes of said oscillator devices, means for superimposing a standard alternating voltage on the voltage of the signal obtained at the end of the final oscillator device, means for detecting the top of the curves corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one component of the oscillator devices.

11. A system for generating oscillations especially intended for television, which comprises, in combination, at least two oscillator devices, each oscillator device including a pentode tube, another tube arranged to be periodically polarized, a condenser connected with said tubes in a manner to slowly discharge through the first mentioned tube and to be suddenly charged through the second mentioned tube when the latter is not blocked by polarization, an auxiliary tube connected to accelerate the beginning of the charge of the condenser, potentiometers connected with the screens of the first mentioned tubes for adjusting the screen voltages thereof, so as to determine the plate currents thereof, coupling means for connecting one of the oscillator devices with the other, the respective condensers of these oscillator devices being chosen of different capacities so as to obtain the desired ratio of the respective frequencies of said oscillator devices, means for transmitting the voltage from one oscillator device to the other, a single potentiometer for feeding a potential to the potentiometers provided for adjusting the screen voltages of the first mentioned tubes of said oscillator devices, means for superimposing a standard alternating voltage on the output of the final oscillator device, means for detecting the tops of the curves corresponding to the superimposed voltages, and means for causing the voltage thereby obtained to act on at least one of the oscillator devices.

12. A system for producing oscillations which comprises, in combination, a plurality of oscillator devices interconnected with one another so that the frequency of one depends upon the frequency of the preceding one, at least one oscillograph, means coupling the plates of said oscillograph with at least two of said oscillators, means for superimposing a standard alternating voltage on the output of the final oscillator device, means for detecting the tops of the curve corresponding to the superimposed voltages, and

means for causing the voltage thereby obtained to act on at least one of the oscillator devices.

HENRI DE FRANCE.

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