

Feb. 13, 1940.

K. SCHLESINGER

2,190,504

METHOD OF GENERATING IMPULSES AND IMPULSE GENERATOR

Filed Feb. 26, 1937

4 Sheets-Sheet 1

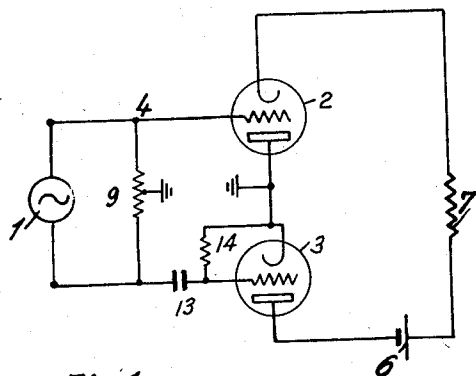


Fig. 1

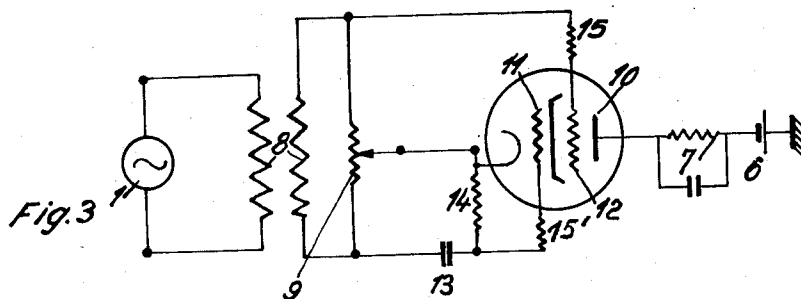


Fig. 3

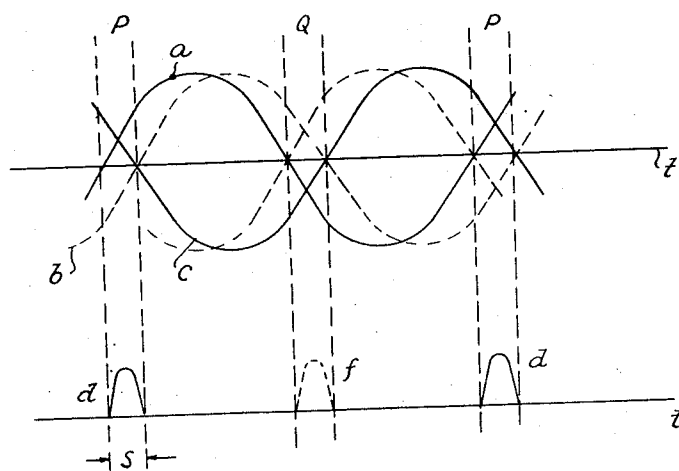


Fig. 2

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4 Sheets-Sheet 2

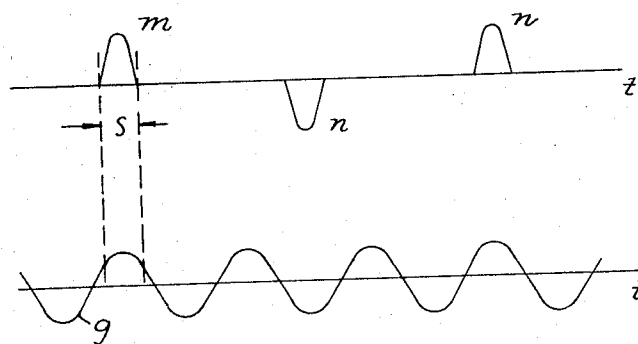
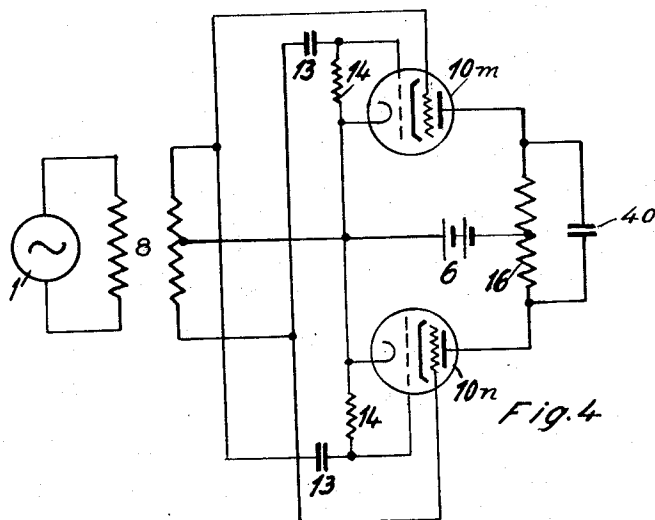


Fig. 5

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4 Sheets-Sheet 3

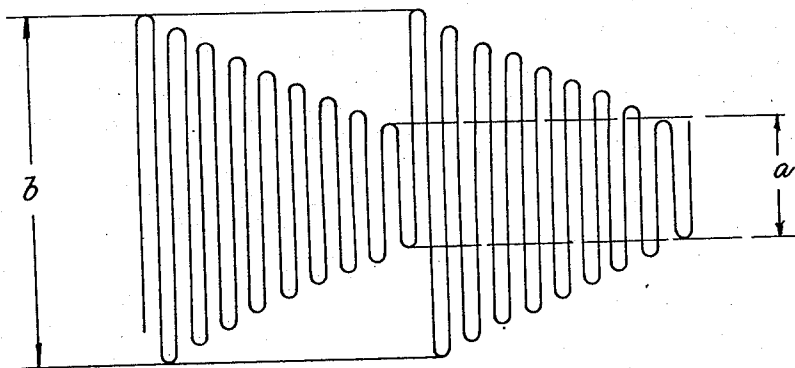


Fig. 10

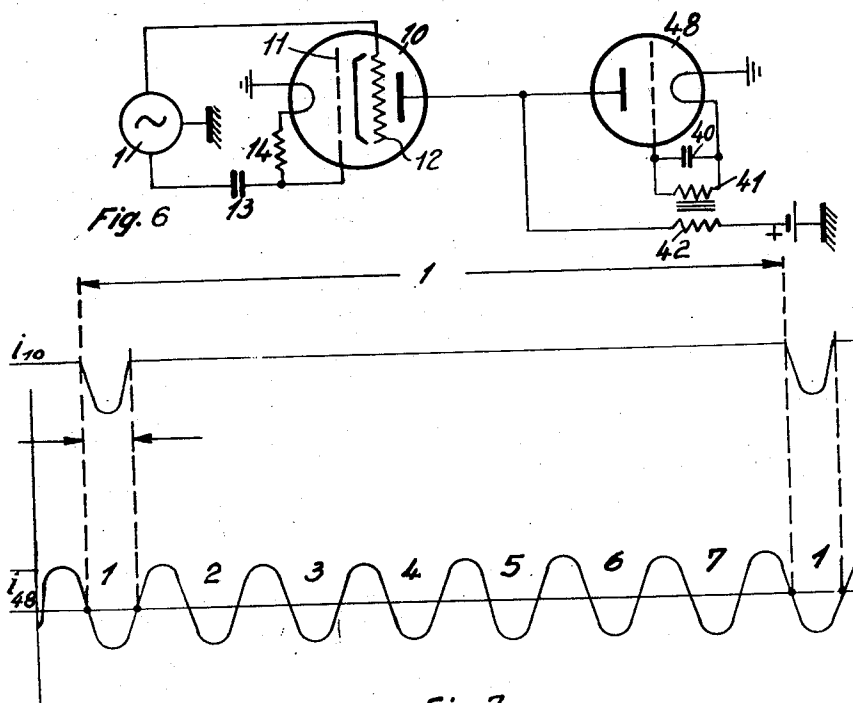


Fig. 7

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4 Sheets-Sheet 4

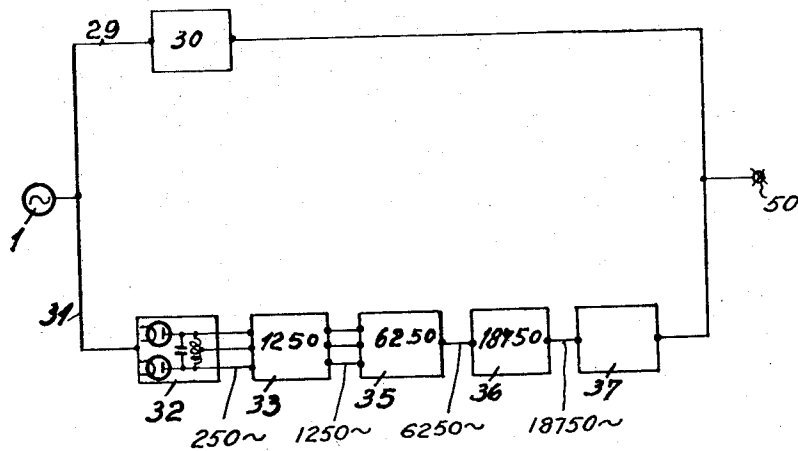


Fig. 8

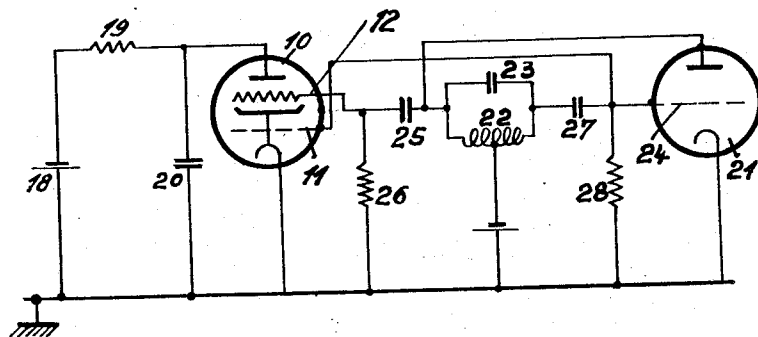


Fig. 9

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UNITED STATES PATENT OFFICE

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METHOD OF GENERATING IMPULSES AND
IMPULSE GENERATORKurt Schlesinger, Berlin, Germany, assignor, by
meane assignments, to Loewe Radio, Inc., a
corporation of New YorkApplication February 26, 1937, Serial No. 127,894
In Germany March 3, 1936

6 Claims. (Cl. 250—36)

A fundamental problem in the television art consists in deriving a short impulse at a definite point of time from a sine oscillation. The duration and the initiation of the impulse must be fixed with the utmost precision. Dependency on fluctuations of the operating potential, particularly in the case of mains operation, should be as small as possible. The individual properties of the electronic tubes employed should have the least possible effect on the operation.

For solving this problem there have been set forth, for example, circuits, in which condensers are charged and are discharged by way of gas-filled tubes, such as the grid-controlled gas-filled thermionic tubes of the type known by the registered trade-mark "Thyratron". Circuits of this kind, however, are dependent to a large extent on the potential of the mains.

It is an object of the invention to obtain very sharp impulses from a sinusoidal oscillation by using grid-controlled high vacuum thermionic tubes in a kind of push-pull connection.

It is a further object of the invention to replace a pair of tubes by two grids of a single tube.

A further object of the invention is to use the impulses for frequency multiplication.

The present invention is illustrated by means of the accompanying drawings in which

Fig. 1 is a diagram showing the principle of the invention,

Fig. 2 is a graph explaining the function of the connection according to Fig. 1, whilst

Figs. 3, 4, 6, 8 and 9 are diagrams of further developments, and

Figs. 5, 7 and 10 are oscillograms like Fig. 2.

In Fig. 1, 1 is an alternating potential source shunted by a potential divider 2, 2 and 3 are electronic tubes, for example, triodes. The grid of tube 2 is connected directly to one terminal of 9 by means of a lead 4, the grid of tube 3 to the opposite terminal of 9 by way of a phase-shifting device consisting of condenser 13 and resistance 14. The potentiometer 9 is so adjusted that it complies with the relative sensitivity of potential or the steepness of the tubes 2 and 3. With relation to the anode battery 6 and the resistance 7 both tubes are in series. They are provided with a negative grid bias (not shown) just sufficient to suppress the anode current. The operation is best explained by means of the oscillogram in Fig. 2.

The curve *a* represents the potential wave conducted to the grid of tube 2. If the device 13—14 would be in the lead 4, the curve *a* would

be transformed in the curve *b*. As the grid of tube 3 is connected to the opposite terminal, it is fed by a voltage according to curve *c*. Obviously an anode current can only traverse both tubes when both grids permit of the passage. This is the case only during the times *P* as only then the two grids are simultaneously positive. The result consists in sharp and very exactly defined impulses *d* of the anode current the duration *s* of which corresponds to the phase shift between the curves *a* and *b*. To maintain the height of the impulses constant either the outer resistance 7 is made large as compared with the internal resistance, or potential limitation is introduced by reducing the voltage of the anode battery 6, and the like.

If the phase advance *b/a* is replaced by a phase lag, for example by changing the position of the elements 13 and 14, there is obtained in respect of the tube 3 a curve *e*, the phase of which lags behind the curve *a*. It is to be recognized that impulses *f* then occur at the times *Q*.

In Fig. 3 there is shown an embodiment of the invention wherein a pentode 10 replaces the two separate valves 2 and 3 of Fig. 1. The sine generator 1 acts by way of a transformer 8 on a potentiometer 9. The tube 10 is furnished, besides of the screen grid, with two control grids 11 and 12, which are connected like the grids in Fig. 1. The effect of this device is practically the same as that of Fig. 1.

The described method of producing impulses permits of a number of adaptations which are important for the television art. The first use consists in the production of synchronisation signals. This will be readily apparent from the above remarks. If, for example, 1 are the *a-c* mains, synchronizing impulses of the mains frequency are produced. The same result is obtained in respect of the line synchronisation impulses if a generator 1 is available which supplies a sine wave of the line frequency. This may be constituted, for example, by a photoelectric siren. It may, however, also be derived from the mains frequency by frequency multiplication.

The frequency multiplication itself is a second important possibility of employing the method of impulse generation according to the invention. If in Fig. 3, 7 is a self-induction coil and (drawn in dotted lines) a condenser and the circuit 7—40 is tuned to a multiple of the frequency of 1, this circuit will be excited to oscillate at this higher frequency. The duration *s*

of the impulses is preferably made equal to about half the period of the harmonic.

The fading of the amplitude of the higher frequency from one impulse to the next one, caused by the damping of the circuit 16—40, can be reduced to about the half by the push-pull connection of the two tubes 10*m* and 10*n* according to Fig. 4. In order to obtain, for example, a trebling of the frequency, the circuit 16—40 will be tuned to three times the frequency of *l* and the difference in phase between each pair of grids will be adjusted to 120 electrical degrees and consequently the duration of the impulses *s* (Fig. 5) will be 60 degrees. Tube 10*m* generates the impulses *m*, tube 10*n* the inverse impulses *n* so that the circuit at every third half wave of the oscillation *g* receives an impulse and oscillates practically without damping.

The fading of the amplitude may be fundamentally eliminated by another method, in which, as well known per se, the desired high frequency oscillates continuously without damping in reaction coupling and is merely maintained in synchronism by the basic frequency.

According to Fig. 6 the basic oscillation *l* is converted into impulses by a pentode 10 in the manner already described. The point of initiation of these impulses coincides with the passages of the potential *l* through zero and has a high degree of precision. The duration of the impulses, by adjustment of the phase-shifting, is made equal to the half-period of the oscillation which is produced by a triode 48 in the circuit 40/41 and is back-coupled to the coil 42. The two anodes of the tubes 10 and 48 are connected together.

In Fig. 7 there are entered the anode current of the tube 10 and the tube 48. The latter oscillates for example at the seventh harmonic of the basic period *l*. The operation is such that the impulses produced by the tube 10 hook exactly into a corresponding current internal of the harmonic. In this way there is produced a perfect synchronisation of the harmonic oscillations with these impulses.

As known in the case of mixing tubes the tubes 10 and 48 may be arranged in a common vacuum vessel. Also a push-pull scheme may be used.

As regards the constancy, the method is superior to all amplitude methods in which potential values require to be correct. The same may also be employed in cascade and permits, for example, of the generation of synchronisation signals for 343-line television images with triple use of a multiplication of the frequency by "7". For example, a 375-line television image may be synchronized by an assembly according to Fig. 8.

The lighting mains *l* feed an impulse generator 30 such as shown in Fig. 2, which supplies 50 impulses per second having, for example, a duration of 1% of the mains period. This corresponds in the case of an image of approximately 400 lines to a synchronisation loss of 4 lines. The mains feed also a push-pull frequency multiplier 32 increasing 5 times the frequency. Its anode circuit having the frequency of 250 acts on a similar apparatus 33 with the increase 5 and the anode frequency 1250. To this stage there is connected a third multiplier 34 with the increase 5, frequency 6250, and a final one 36, increase 3, frequency 18750. This apparatus is followed by a stage 37 comprising a pentode, which halves the frequency and simultaneously converts it into impulses. A stage of this nature is fully described in the application Ser. No.

92,153 filed July 23, 1936, in adaptation to the interlaced line method. The output of the apparatus 37 and of the apparatus 30 accordingly contains the synchronisation impulses for line and image for 375 lines according to the interlaced line method, derived from a common mains potential *l*.

A third use important in respect of a television receiver is the generation of relaxation oscillations with high-vacuum tubes. As well known, relaxation oscillations are produced fundamentally by the fact that a storage condenser 20 (Fig. 9) is charged by way of a resistance 19 from a direct potential source 18, and is quickly discharged by way of an electronic tube 12. Usually there is employed a gas-filled grid-controlled thermionic discharge tube for this purpose, or high vacuum tubes in a galvanic back-coupling connection (callitron), which, however, are extremely sensitive to variations in the conditions of operation.

According to the invention, there is employed for discharging the condenser 20 a tube 10, like that of Fig. 3, the two grids of which are excited by means of a fundamental-oscillation generator, preferably a small triode 21, back-coupled via 27/28 to an oscillatory circuit 22/23. For example, the inner grid 11 is connected in direct fashion with the grid of the oscillator, whilst the outer grid 12 is connected to the anode via a capacitative coupling 25/26. It is immaterial which of the two capacitative coupling 25/26 or 27/28 is utilized for producing the phase shift. They may both be used, as it is merely wanted that the grids 11 and 12 are not exactly opposite in phase but that there exists a slight difference from that. For the duration of this difference in time, tube 10 becomes emissive and a discharge of the condenser 20 can take place. The number of relaxation oscillations per second are accordingly controlled by adjustment of the frequency of the circuit 22/23, and the duration of the relaxation return is governed by adjustment of the relative phase difference of the coupling elements 25/26 and 27/28. The two tubes 21 and 10 may be combined.

In the final stage of a multiplying cascade the phase fluctuations of the basic curve, which are also multiplied to the same extent as the frequency, exercise a disturbing effect to such extent that self-excitation transmitters are unable to keep pace. According to the invention this interfering is avoided by artificially damping the circuits to such a degree that the width of their band is adapted to the fluctuation in phase of the synchronising oscillation. It may be that the minimum amplitudes are only one half of the maximum amplitudes. In order to obtain exactly equal amplitudes according to the invention, an amplitude selection is provided which permits of the passage only of a certain amplitude range of the frequency train about the zero line. It may be adjusted as desired for example to 30% of the maximum stroke, and then allows oscillations to pass, for example only up to 3 volts, assuming the maximum amplitude amounts to 10 volts. All oscillations which are more powerful than 3 volts are cut off, i. e., appear behind the apparatus in the form of rectangular waves having a constant peak of 3 volts. Behind the amplitude selection there is connected a resonance circuit, which produces from these rectangular waves with constant peak sinusoidal waves of constant amplitude.

In Fig. 10 there is shown diagrammatically the

oscillogram of an oscillation of this nature for the purpose of explaining the effect. It is to be recognized that there is at least a range *a* below which the amplitude does not fade, whilst on the other hand there is a range *b* reached by the top values of the groups. It is the object of an amplitude selection according to the invention to allow the passage only of the amplitude range *a* and to withhold the peaks *b*.

Finally, impulses which initiate in regular fashion upon passage of the control oscillation through zero and the duration of which is definitely determined by a phase timing member (condenser-resistance) are generated from the sine waves of constant amplitude and proper frequency thus obtained. These impulses may be employed in direct fashion for modulating the synchronisation portion of a television transmitter.

I claim:

1. An arrangement for producing short impulses by sine oscillations comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, two discharge gaps and an anode resistance in series, and two grids each controlling one of said gaps, the terminals of said generator being connected in push-pull to said grids, one terminal directly, the other terminal via said device shifting the phase by an amount substantially less than 180 degrees.

2. An arrangement for producing short impulses by sine oscillations comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, a tube provided with two control grids and an anode resistance in series, the terminal of said generator being connected in push-pull to said grids, one terminal directly, the other terminal via said device shifting the phase by an amount substantially less than 180 degrees.

3. An arrangement for producing short impulses by sine oscillations comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, a tube provided with two control grids and an anode resistance

in series, the terminals of said generator being connected in push-pull to said grids, one terminal directly, the other terminal via said device shifting the phase by an amount substantially less than 180 degrees, said phase-shift-device consisting of a resistance-condenser combination.

4. An arrangement for producing short impulses by sine oscillations comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, two discharge gaps and an anode resistance in series, and two grids each controlling one of said gaps, the terminals of said generator being connected in push-pull to said grids via said phase-shift-device for energizing said grids with a phase-difference of substantially less than 180 degrees.

5. A frequency multiplier comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, a tube provided with two control grids and an anode resistance in series, the terminals of said generator being connected in push-pull to said grids, one terminal directly, the other via said phase-shift devices for energizing said grids with a phase-difference of substantially less than 180 degrees, said anode resistance being coupled to an oscillatory circuit tuned to a multiple of the frequency of said generator.

6. A frequency multiplier comprising a sine wave generator, a phase-shift-device, a circuit containing a source of direct current, a tube provided with two control grids and an anode resistance in series, the terminals of said generator being connected in push-pull to said grids, one terminal directly, the other via said phase-shift-device for energizing said grids with a phase-difference of substantially less than 180 degrees, said anode resistance being coupled to an oscillatory circuit tuned to a multiple of the frequency of said generator for obtaining oscillations of said multiple frequency, the duration of said impulses being adjusted so as to be approximately equal to half a period of said multiple-frequency.

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