Sept. 5, 1933. W. BUSCHBECK 1,925,520

FREQUENCY MULTIPLICATION

Filed Nov. 8, 1930

Fig. 1

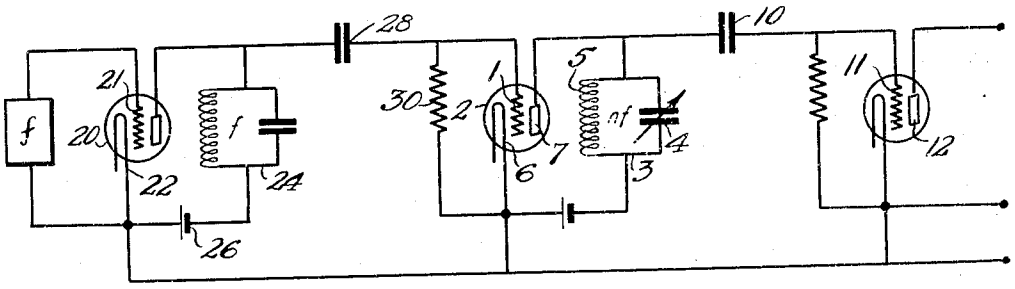
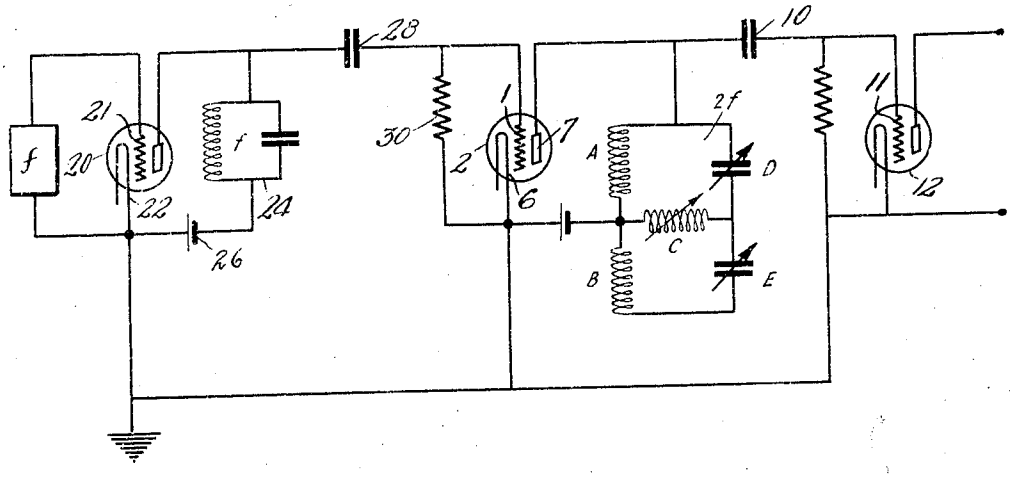


Fig. 2



INVENTOR
WERNER BUSCHBECK

BY

ATTORNEY

Patented Sept. 5, 1933

1,925,520

UNITED STATES PATENT OFFICE

1,925,520

FREQUENCY MULTIPLICATION

Werner Buschbeck, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application November 8, 1930, Serial No. 494,270, and in Germany November 13, 1929

2 Claims. (Cl. 250—36)

This invention relates to frequency multiplication and especially toward the provision of methods and means for eliminating energy of undesired frequency in an electron discharge frequency multiplier.

In the accompanying drawing, Figure 1 illustrates a frequency multiplier, and

Figure 2 illustrates a frequency multiplier having means for eliminating in the output circuit thereof energy of undesired frequency.

If the grid 1 of a tube 2 is fed with a potential of frequency f (see Figure 1), then, provided one does not work in the rectilinear part of the characteristic curve, it is generally feasible to derive all higher harmonics from the composite wave in the plate circuit 3 of tube 2. In other words, the plate current includes frequencies f, $2f$, $3f$, nf. If the original frequency is to be doubled, then the plate circuit 3 comprising the capacity 4 and inductance 5 is tuned to wave $2f$, and as a result it becomes a high impedance for this frequency, while the other harmonics, according to the kind of circuit scheme used, find a more or less low impedance as they are drained or short-circuited between the plate 7 and the filament 6. Particularly disturbing is the potential due to the lower harmonics, in the present instance the potential between anode or plate and filament or cathode due to the fundamental wave which conjointly with the potential of the desired harmonic or overtone is fed through a condenser 10 to the grid 11 of the following tube 12.

The frequency f applied between the grid 1 and filament 6 of tube 2 may be obtained in any manner. As illustrated, a tube 20 may have its grid 21 and filament 22 energized by oscillations at frequency f as shown. These oscillations are amplified in 20 and are repeated in the output circuit thereof which includes the parallel circuit 24 resonant to the frequency f and a source 26. Potential oscillations at frequency f are applied through blocking condenser 28 to the control electrode 1 of tube 2. Tube 2 is biased through resistance 30 to a point on its characteristic curve at which rectification takes place.

Inasmuch as the stage wherein frequency doubling is insured operates with a high negative biasing potential, in order to secure satisfactory efficiency, slight fluctuation at the rhythm of frequency f of the voltage applied to its grid will suffice in order to bring about in the plate circuit a far greater percentage modulation at this frequency. It is therefore necessary that the potential of frequency f applied to the grid of the next doubling stage should be as low as feasible, and this, as is well known, is accomplishable by the aid of intermediate filter chains. The latter will be especially effective if they comprise short-circuiting and stopper units which are tuned to the frequency in question. However, filter circuits of this kind are difficult to tune inasmuch as every change in the tuning of short-circuit or stopper circuits at the same time affects the tuning to the desired useful wave.

According to the present invention a short-circuiting unit is inserted between the plate and the filament for frequency f, said unit to be so disposed that its exact balancing or adjustment to the stray frequency f will not affect the tuning of the circuit for the useful frequency $2f$. This end is attained as shown in Figure 2 by tuning the unit for passing the fundamental frequency by means of an inductance coil which is connected at points being equipotential in relation to the useful frequency, that is, the frequency to be developed. More in particular coils A and B (Figure 2) are tuned with the series capacities D and E to frequency $2f$. B and E combinedly, so far as the fundamental wave f is concerned, result in a capacity which by the aid of the tuning coil C arranged in parallel thereto, and connected as shown at points on the circuit D, E, A, B, which are of equal potential with respect to the potential oscillations of the wave at frequency $2f$, may be rendered inductive. This inductive reactance taken with capacity D will result in a short-circuiting unit for undesired frequency f, that is, a unit of low impedance to the fundamental frequency.

I claim:

1. A device for multiplying the frequency of alternating currents and transferring a desired harmonic of said multiplied frequency only to a thermionic repeater tube having cathode and control grid electrodes comprising, a thermionic frequency multiplier tube having anode, cathode and control grid electrodes, a circuit for applying alternating current potential to the control grid electrode of said frequency multiplier tube, a pair of inductances having adjacent terminals connected together to connect said inductances in series, a pair of capacities having adjacent terminals connected together to connect said capacities in series, a circuit for connecting the free end of one of said inductances to the free end of one of said capacities to the anode of said frequency multiplier tube and by way of a capacity to the control grid electrode of said repeater tube, a connection between the free end of the other terminal of the other inductance and the free

terminal of the other of said capacities, said capacities and inductances together being tuned to a multiple of the frequency of the alternating current applied to the control grid electrode of said frequency multiplier tube, a connection between the adjacent terminals of said series inductances and the cathode of said frequency multiplier tube, and a tuning inductance connecting adjacent terminals of said inductances to adjacent terminals of said capacities to tune the same to the frequency of the alternating current applied to the control grid electrode of said frequency multiplier tube.

2. A circuit for multiplying the frequency of alternating currents including, a thermionic tube having anode, cathode, and control grid electrodes, a circuit for applying the alternating currents to be multiplied to the control grid electrode of said tube, a pair of inductances having adjacent terminals connected together, a pair of capacities having adjacent terminals connected together, a circuit for connecting the free end of one of said inductances to the free end of one of said capacities and to the anode of said tube, a connection between the free terminal of the other inductance and the free terminal of the other of said capacities, said capacities and inductances together being tuned to a multiple of the frequency of the alternating current applied to the control grid of said tube, a connection between the adjacent terminals of said series inductances and the cathode of said tube, and a tuning inductance connecting adjacent terminals of said inductances to adjacent terminals of said capacities to tune the same to the frequency of the alternating current applied to the control grid electrode of said tube.

WERNER BUSCHBECK.