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CONNECTION FOR ELECTRON TUBES FOR THE MULTIPLICATION OF FREQUENCY

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Fig. 1

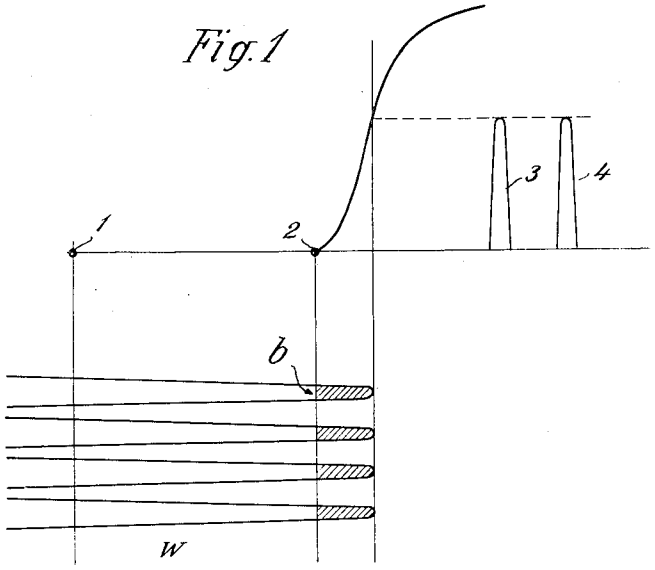
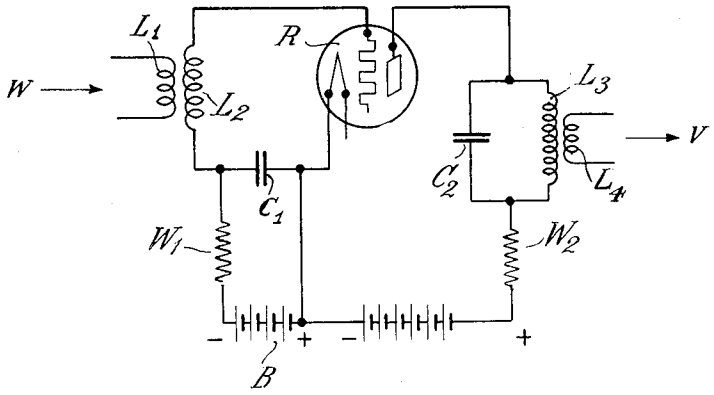


Fig. 2



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CONNECTION FOR ELECTRON TUBES FOR THE MULTIPLICATION OF FREQUENCY

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3 Claims. (Cl. 250—36)

Numerous methods and means for multiplying the frequency of an alternating current have been devised. One of these methods comprises impressing the alternating current on an electron tube having a grid that is so highly biased negatively that only the uppermost portions in the positive peaks of the impressed alternating current are effective in producing space current impulses in the output or anode circuit of the electron tube. Devices of this type have been used for a great variety of purposes, especially in the case of radio transmitting stations where they often provide the common frequencies now used for broadcasting programs. However, up to the present time faultless operation of frequency multipliers of the electron tube type, in particular, has not been attained. It is an object of this invention to provide means whereby an electron tube may be made to operate to advantage as a faultless frequency multiplier.

According to this invention, a fundamental or monitored frequency is supplied from a central station. From this fundamental frequency higher harmonics are obtained by means of frequency multiplying devices. The resultant frequencies produced in accordance with this invention may, by proper adjustment of the associated apparatus, be made to have the same amplitude and a period or cycle individual to the particular transmitting apparatus supplied therewith. However, it is well known in transmission art that it is not possible to supply the fundamental frequency to all stations with the same intensity or amplitude. This variation in amplitude of the fundamental frequency may be attributed to the practice of using the standard electric cables of telephone and telegraph lines for conveying the current to the various broadcasting stations. Furthermore, owing to the changes in load and in demand on the cables, apparatus broadcasting on a predetermined wave length or frequency may be thrown completely out of operation due merely to a very slight drop in the amplitude of the current supplied.

For example, variations in the amplitude of the current or potential supplied of only one percent may cause the frequency multiplying device to become inoperative. That such small amounts will be of some influence will easily be explained by the fact, that the operation is to be carried out not by a single step of multiplication but with a plurality of steps, generally three steps in succession and in consequence, a fault occurring in the first step will become perceptible in the last step relatively multiplied. For these reasons, experiments made with an electron tube device adapted for frequency multiplication as disclosed by the appurtenant literature, have frequently failed.

According to the invention the inconveniences referred to can be avoided since the negative bias is divided into a firmly adjusted bias and a bias which will change in dependency on the grid current of the multiplying tube or valve.

An arrangement according to the invention is illustrated by way of example in the drawing.

Figure 1 shows diagrammatically the characteristic curve of the valve, and

Figure 2 is a diagram of the connections.

In Figure 1 the characteristic curve of the tube and the variations of the fundamental frequency supplied or of the anode currents produced respectively, are represented diagrammatically.

The central line or operating point, about which the alternating voltage W supplied to the grid fluctuates (when broadcasting on equal waves this would be the fundamental frequency supplied) is considerably displaced to the negative territory to point 1 by means of a predetermined negative bias. If an alternating frequency is allowed to operate about this mean value, only the uppermost portions in the positive peaks of the alternating frequency (represented by hatched lines in the drawing) in the tube are effective, since simply from the point 2, the point of issue of the marking line, anode currents can occur, as clearly follows from the said illustration. Therefore within the anode circuit the points of voltage 3, 4 and so on will occur, as represented.

If heavy variations are concerned, the upper (hatched) section of the alternating frequency supplied to the grid will shift from the point 2 to the left hand side, and there can occur no longer any anode current.

But even at slight changes the arrangement will be subject to failure, for the base *b* of the small hatched areas in the drawing will change with the variations of the amplitude of the alternating frequency W. If the alternating frequency is cut somewhat closer to the tip of the peaks by the straight line passing through point 2, the value *b* will become smaller.

In consequence the period will change too, during which an anode current can occur in the tube. The interval between the impulses will increase by the period of time by which the impulse of the anode current decreases. Thus an oscillatory circuit situated in the anode circuit of the tube is impinged upon by a current pulse for less time and at greater intervals and the system will oscillate at another frequency than formerly. As in

practice filter circuits are connected to the multiplying tube, no trace will be found beyond the said filter of any but the desired frequency. Undesirable results will occur if the full amplitude of the fundamental frequency is used.

For that reason according to the invention the negative biassing of the grid is constituted by a fixed portion and a changing portion, which will undergo changes in dependency on the grid-current of the tube. The working point of the characteristic curve of the tube must be arranged in such a manner, that work is done in the positive territory, so that upon occurrence of the impulses of positive voltage in the tube a grid current will flow. Thus it is rendered possible to utilize the grid current for the control of the variable biassed portion.

For that purpose various means may be employed, which are shown in the diagram according to Figure 2.

Alternating frequency is supplied by way of the inductance L_1 to the inductance L_2. Connected to the inductance L_2 is the grid of the tube R, in the anode circuit of which an oscillatory circuit is situated, formed of the elements C_2 and L_3, from which circuit the multiplied frequency V is drawn. A highly negative bias is imparted to the grid and the source of bias B is shunted by the capacity C_1. The connection described so far is the normal one customary for frequency multiplications of this kind.

As a first means for obtaining the effect according to the invention the use of a transformer having a high leakage reactance is suggested. This may be done by loosely coupling the windings, by increasing the number of turns on both primary and secondary, or, in the case of an iron core transformer, by adjustment so that the peak of the desired voltages in the primary occurs at a value of grid current which saturates the core. If this transformer has a high leakage reactance its secondary voltage will be automatically reduced by a stronger grid current. As this means in most instances will not suffice alone, a resistance W_1 is inserted in the lead for the continuous current bias supply of the grid. This resistance will cooperate with the transformer to act in the manner of an automatic biassing device and in the case of amplitude fluctuations the grid current will also assist to automatically adjust the proper bias. As a further means, which suitable may be employed in combination with the two other arrangements, a resistance W_2 is provided in the lead to the anode. By this means the voltage in the tube will be subjected to slight fluctuations only within certain limits when the anode voltage drops and the anode current is correspondingly reduced through the slight drop of voltage at the resistance W_2.

We claim:

1. A frequency multiplier comprising a vacuum tube having anode, cathode and grid circuits, means for biasing the grid of said tube at least to the cut-off point, inductive means for impressing an alternating current on said grid circuit in such a manner that current of one polarity only causes an impulse of current to flow in the anode circuit, and means including a resistance in said grid circuit for changing the bias in said grid circuit in proportion to the changes in amplitude of said current.

2. A frequency multiplier comprising a vacuum tube having anode, cathode and grid circuits, means for biasing the grid of said tube at least to the cut-off point, means for inducing an alternating current in said grid circuit in such a manner that the positive peaks of said current cause an impulse of current to flow in the anode circuit, and means including a resistance in said grid circuit for changing the bias in said grid circuit in proportion to the changes in amplitude of said positive peaks.

3. A frequency multiplier comprising a vacuum tube having anode, cathode and grid circuits, means for biasing the grid of said tube at least to the cut-off point, means for inducing an alternating current in said grid circuit in such a manner that the positive peaks of said current cause an impulse of current to flow in the anode circuit, and means including a resistance in said grid circuit for changing the bias in said grid circuit in proportion to the changes in amplitude of said positive peaks, and for making a predetermined portion of each positive impulse effective to render said vacuum tube operative.

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