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C. R. KEITH

FREQUENCY TRANSLATING CIRCUITS

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Fig. 1.

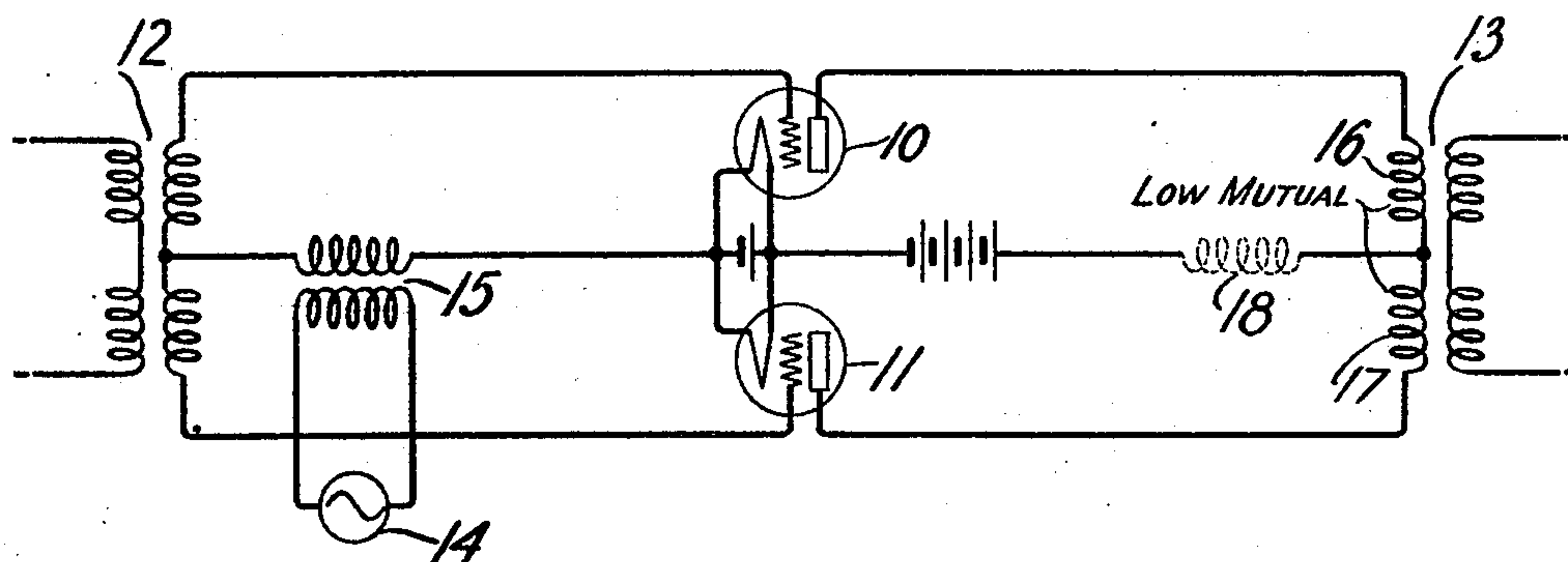


Fig. 2.

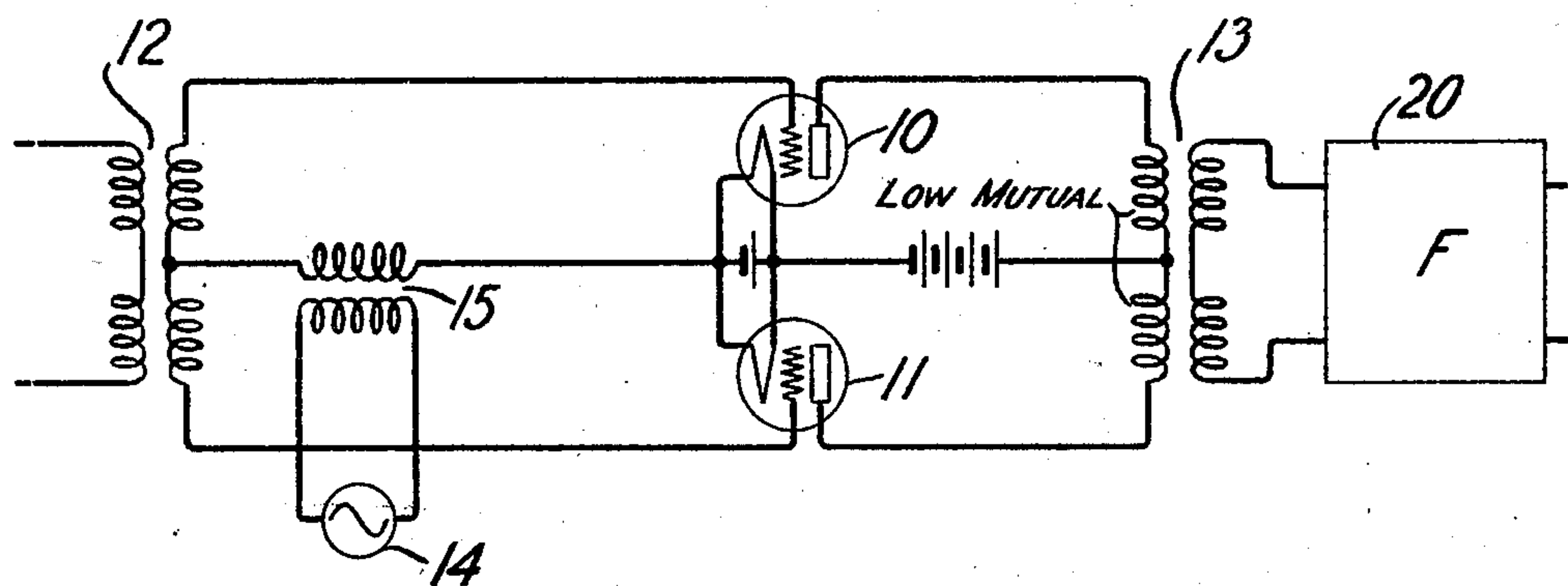


Fig. 3.

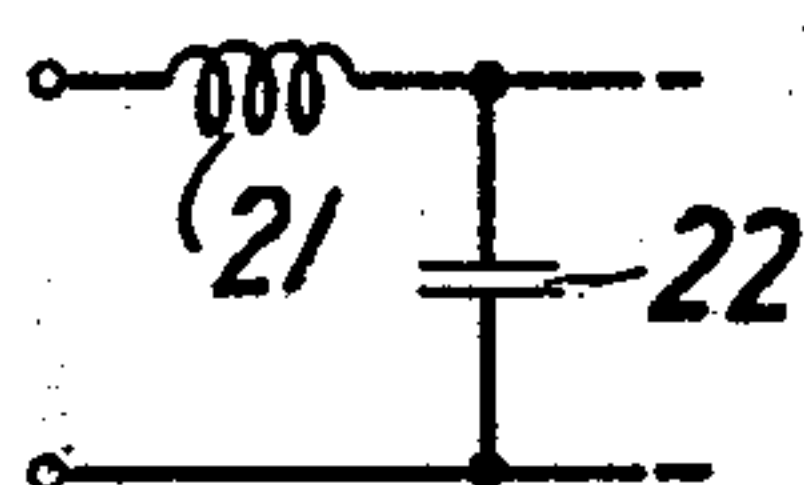
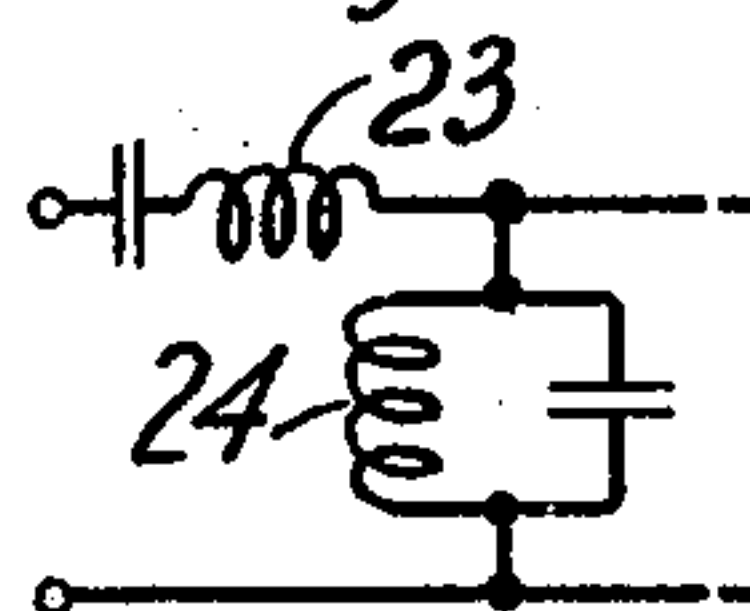


Fig. 4.



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FREQUENCY TRANSLATING CIRCUITS.

Application filed January 31, 1927. Serial No. 164,694.

This invention relates to frequency translating circuits and particularly to such circuits employing electric discharge devices in the input circuit of which the frequency translation takes place, for example grid current modulation in the grid circuit of a three-electrode vacuum tube.

An object of this invention is to improve the efficiency of frequency translating circuits.

A further object of the invention is to prevent output current modulation or detection in frequency translating circuits of the input current modulation or detection type.

Frequency translating circuits, which are defined for the purpose of this specification as including both modulators and demodulators or detectors, may employ electric discharge devices for performing the frequency translation function in which case they may be divided into two main types: the input circuit frequency translation, or, as more commonly known the grid current modulation, type, in which the combination is produced in the grid or input current circuit and is due to the curvature of the grid current characteristic; and the output current frequency translation, or as more commonly known the plate current modulation, type, in which the combination is produced in the plate or output circuit and is due to the curvature of the plate current characteristic.

The products resulting from these two types of modulation or detection may be of opposite phase so that it is often desirable to prevent one type of modulation when the other is being used to produce a useful output product.

When input current modulation or detection is used for producing the useful output products, the discharge device acts as an amplifier for the modulation products produced in the input circuit. However, the discharge device may operate to also transmit the uncombined waves to the output circuit where they may be combined to produce output modulation or detection products which, as stated above, may be of opposite phase to the modulation products produced by the input current.

In accordance with this invention there is

provided a circuit arrangement for increasing the impedance of the output circuit to uncombined waves to prevent output current modulation or detection in a circuit producing grid current modulation products.

In a preferred embodiment this invention comprises a balanced input current modulator or detector of the conjugate type, in which waves of different characteristics are impressed upon the input circuit through the individual branches and the common branch, respectively, having an output transformer with a primary winding connected in the output circuit of each of the discharge devices, the coupling between the primary windings being low to give the output circuit a high impedance to the wave impressed upon the common input branch, and having a filter or other impedance network connected in the output circuit, the network being so designed as to give the output circuit a high impedance to the wave impressed upon the individual input branches. By means of this arrangement the impedance of the output circuit is made high for both of the uncombined waves and output current modulation is substantially eliminated.

This invention is not limited to the combination of these features. In practice it may be found that the use of the special output transformer having low mutual inductance between the portions of the primary winding will produce sufficient effect to reduce the plate current modulation to a practically negligible value. In other cases it may be desirable to merely use the filter or other impedance network. In some types of circuits such a network may be designed to give the output circuit a high impedance to both of the uncombined waves.

This invention is illustrated in the accompanying drawing in which:

Fig. 1 shows diagrammatically an embodiment of the invention employing an output transformer having low mutual inductance between the portions of the primary windings;

Fig. 2 shows an embodiment of the invention employing a filter having such impedance characteristics as to prevent plate current modulation; and

Figs. 3 and 4 show typical filter sections which are well adapted for use in the circuit of Fig. 2.

In the circuit of Fig. 1, two electric discharge devices 10 and 11 are connected in push-pull relation between an input transformer 12 and an output transformer 13. Signal waves to be modulated or demodulated are supplied through the input transformer 12. Carrier waves from a source 14 are supplied to the input circuit through a transformer 15 connected in the common input branch.

The signal and carrier waves are combined in the input circuit of the devices 10 and 11 to produce grid current modulation products, in the manner described in the application of E. Peterson, Serial No. 696,766, filed March 4, 1924, by including in the input circuit an impedance of such value that when the grids are positive the greater part of the potential drop takes place across this impedance while during the negative portion of the cycle the potential drop divides between the devices and the impedance. In the circuit shown herein the secondary winding of the transformer 12 is designed to act as this impedance. The grid current modulation products are amplified by the devices 10 and 11 and transmitted to the load circuit through the output transformer 13. The coupling between the primary windings 16 and 17 is made low which gives the same effect as though an inductance coil 18 were connected in the common output branch. In this way the output circuit is given a high impedance to the carrier wave impressed upon the common input branch and plate current modulation is suppressed, while the transmission of the grid current modulation products is practically unaffected.

In the circuit of Fig. 2 the electric discharge devices 10 and 11 are similarly arranged to produce grid current modulation products which are amplified by the devices and transmitted through the output transformer 13 and the filter 20 to the load circuit. As in the circuit of Fig. 1 the transformer 13 is designed to have low mutual between the primary windings to give the output circuit a high impedance to the carrier wave. The filter 20 is so designed that it gives the output circuit a high impedance to the signal waves while permitting the modulation products to be efficiently transmitted.

Fig. 3 shows a low pass filter section well suited for use in the filter 20 when the circuit is used as a demodulator. This section comprises a series inductance 21 and a shunt condenser 22, and by terminating the side adjacent the output transformer 19 in a series arm a high impedance is offered to waves of frequencies above the cutoff.

Fig. 4 shows a band pass filter section well suited for use in the filter 20 when the cir-

cuit is used as a modulator. This section comprises a resonant circuit 23 in the series arm and an anti-resonant circuit 24 in the shunt arm. By terminating the side of the filter adjacent the output transformer in a series arm a high impedance is offered to waves outside the transmission band.

In an unbalanced circuit the filter or network may be designed to give the output circuit a high impedance to both of the uncombined waves.

What is claimed is:

1. A frequency translating circuit comprising a pair of electric discharge devices each having a cathode, an anode, and a grid, a divided input circuit therefor having an individual portion connected to each of said grids respectively and a common portion connected to said cathodes, means for impressing waves of different characteristics upon said individual and common portions respectively to produce grid current frequency translation, an output transformer having a primary winding connected between the anode and cathode of each of said devices, the coupling between said windings being low to give a high output impedance to one of said waves to prevent output current frequency translation.
2. A frequency translating circuit comprising a pair of electric discharge devices each having grid, filament and plate electrodes, circuits for associating said devices in push-pull relation, means in conjugate relation for supplying carrier waves and signal waves to the input circuit, means for causing intermodulation of said waves in said input circuit, and a transformer having a two section primary winding connected in the plate circuit, said primary windings having leakage reactance whereby the inter-modulation of said waves in the plate circuits is prevented.
3. A frequency translating circuit comprising a pair of electric discharge devices, each having a cathode, an anode and a grid, a divided input circuit therefor having an individual portion connected to each of said grids, respectively, and a common portion connected to said cathodes, means for supplying waves of different characteristics to said individual portions and said common portion, respectively, to produce input current frequency translation, an output transformer having a primary winding connected to the anode and cathode of each of said devices, the coupling between said primary windings being low to provide a high impedance to the waves supplied to said common input portion to prevent output current frequency translation.
4. A frequency translating circuit comprising a three-electrode electric discharge device, an input circuit therefor, means for supplying waves of different characteristics to said input circuit to produce input current frequency translation, an output circuit

therefor, and an impedance network connected to said output circuit and having a high impedance at the frequency of at least one of said waves for preventing output current frequency translation.

5 5. A frequency translating circuit comprising a pair of electric discharge devices each having a cathode, an anode and a grid, a divided input circuit therefor having an individual portion connected to each of said
10 grids, respectively, and a common portion connected to said cathodes, means for supplying waves of different characteristics to said individual and common portions, respec-

tively to produce grid current frequency translation, an output transformer having a primary winding connected to each of said devices, the coupling between said primary windings being loose to provide a high impedance to the wave supplied to the common input portion, and an impedance network
20 connected to said transformer and having a high impedance to the wave supplied to the individual input portions.

In witness whereof, I hereunto subscribe
25 my name this 27th day of January, A. D. 1927.

CLYDE R. KEITH.