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FREQUENCY CHANGING CIRCUITS

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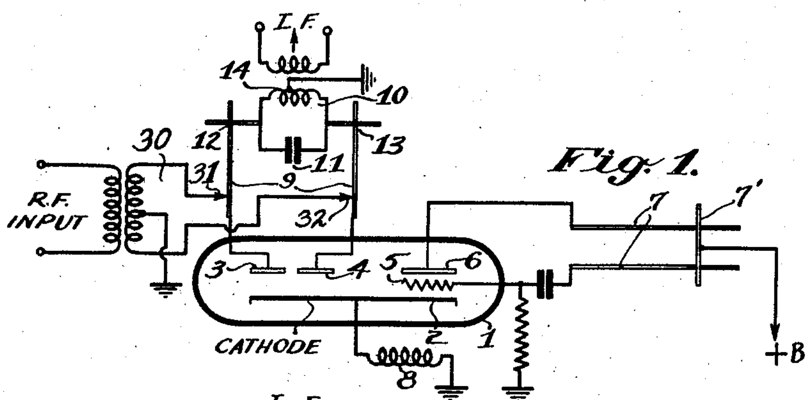

Fig. 1.

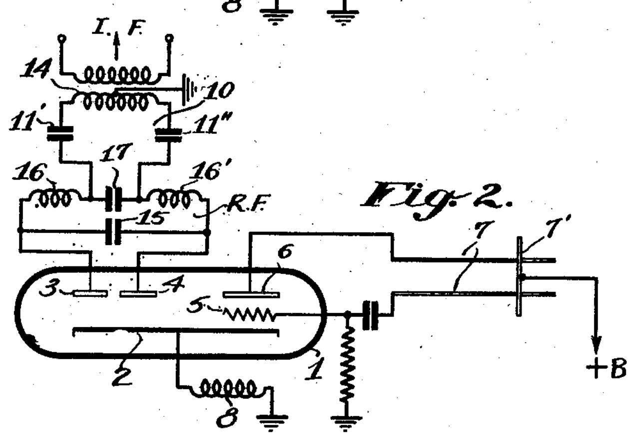

Fig. 2.

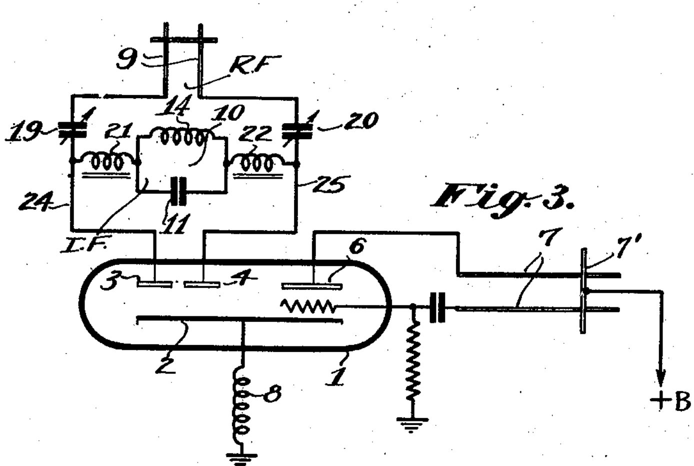

Fig. 3.

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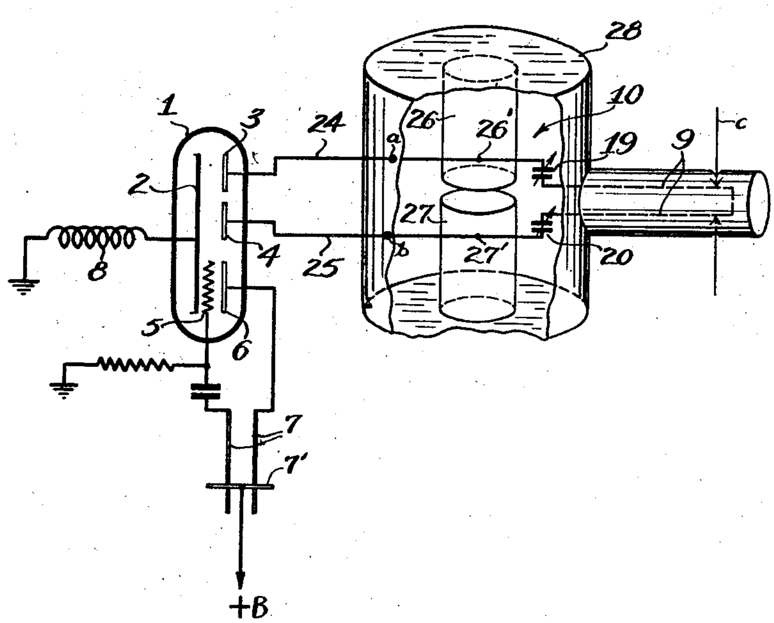
Fig. 4.



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2,441,452

FREQUENCY CHANGING CIRCUITS

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12 Claims. (Cl. 250—20)

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This invention relates to a frequency changing device or a device for wavelength transformation, more particularly of very short waves. In superheterodyne reception of ultra-short waves it is generally necessary for the oscillator tube to generate oscillations whose fundamental frequency is a subharmonic of the auxiliary oscillation required for the mixture, since the generation of an oscillation of very high and sufficiently constant frequency involves practical drawbacks.

Circuits for wavelength transformation or frequency changing have previously been proposed in which the oscillations of ultra-short wavelength to be received are supplied in push-pull to the device, since thus practical advantages are obtained, such as a decrease of the damping of the high-frequency oscillations.

The invention has for its purpose to provide a similar device for frequency changing or wavelength transformation in which the damping of the high-frequency input circuit is reduced to a minimum and in which, in addition, the advantage is obtained that substantially no oscillations locally generated can penetrate into the high-frequency section. The circuit of this device may be made very simple from the point of view of the construction while even if the fundamental wave of the oscillations locally generated is used as an auxiliary oscillation for the frequency transformation, there is no risk of the auxiliary oscillation being "pulled along" by the high-frequency oscillation.

According to the invention, for this purpose, in a device for wavelength transformation, more particularly of ultra-short waves, which comprises two identical rectifying systems and an oscillatory system in which the received high-frequency oscillations are supplied in push-pull to the two rectifying systems and the intermediate-frequency oscillations are derived in push-pull from the two rectifying systems, the cathodes of the three systems are connected to each other for high-frequency currents, and connected, via circuit elements constituting a high impedance at least for the auxiliary oscillation used for the frequency transformation, to a point of constant potential.

In this device use is preferably made of a discharge tube containing two diodes and a triode, of which the cathodes are connected to each other inside the tube.

The invention will be explained more fully by reference to the accompanying drawings in which Fig. 1 discloses one embodiment of a frequency changing system according to the invention, utilizing a double diode-triode tube and in which the radio frequency input is coupled to a Lecher wire system which is connected to the anodes of the double diode; Fig. 2 shows an embodiment of the invention similar to Fig. 1 except that the high frequency Lecher wire system is replaced by a high frequency tuned circuit; Fig. 3 is a further embodiment in which the high frequency circuit is constituted by a Lecher wire system capacitively coupled to the diode anodes and the intermediate frequency circuit is coupled to the diode anodes by means of high frequency chokes; and Fig. 4 is an embodiment which is the electrical equivalent of that shown in Fig. 3 but in which the intermediate frequency circuit assumes a different construction.

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Referring to Fig. 1 there is shown a tube 1 which contains two diodes 3, 2 and 4, 2, together with a triode 5, 6, 2, of which the cathode 2 is common. The grid 5 and the anode 6 of the triode are connected to a Lecher system 7 which is so tuned by the shorting bar 7' that the triode system generates oscillations whose frequency is a subharmonic of the sum of the frequencies of the received oscillations and the intermediate-frequency oscillations, it being possible to use any subharmonic whether even or odd. An impedance comprising an induction coil 8 is connected between the cathode 2 and earth, so that the cathode 2 has applied thereto an alternating voltage relatively to earth which has the frequency of the auxiliary oscillation required for the frequency transformation. The two diode-anodes 3 and 4 are connected to a Lecher-system 9 which has the received oscillations from a radio frequency input circuit 30 supplied to it by means of the sliding connections 31 and 32. In the embodiment concerned the tuning of this Lecher system is effected by sliding an intermediate-frequency circuit 10, made as a unitary structure and comprising a condenser 11 and a coil 14, on the Lecher wires into the correct position. The condenser 11 has such a value that it substantially constitutes a short-circuit for the received high-frequency oscillations. Since, on the one hand, the received oscillations are supplied in push-pull to the diode-anodes 3 and 4 and, on the other hand, the cathode 2 has a high-frequency potential relatively to earth which has the frequency of the auxiliary oscillation required for the frequency transformation, it is evident that mixture will occur in the diodes so that the intermediate-frequency oscillations are taken off in push-pull from the two diode-anodes 3 and 4 and hence from the circuit 10. Since in this circuit the cathodes of the two diodes are directly connected to each other, the damping exerted by the tube 1 upon the Lecher system 9 is very weak. The same remark applies, though to a less extent, if use is made of separate diodes. In this case the cathodes should be connected to each other by as short a conductor as possible. It is also clear that oscillations of the frequency of the oscillations locally generated cannot penetrate either into the intermediate-frequency section, or into the high-frequency section as such, while there is no risk of the auxiliary oscillations being pulled along by the received oscillations, even if their frequencies approach each other, since the oscillations locally generated are supplied as single-phase oscillations and the high-frequency oscillations are supplied in push-pull to the device.

Consequently the circuit 10 is preferably made completely symmetrical relatively to the Lecher system 9. In this case the contact points 12 and 13 can also be connected to tappings on the coil 14 of the circuit 10 which are symmetrically provided relatively to each other. Thus the additional advantage is obtained that the impedance of the intermediate-frequency circuit may be better matched to the diode, since at the points of the contacts 12 and 13 a potential node for the high-frequency oscillations will occur, high-frequency oscillations cannot penetrate into the intermediate-frequency circuit 10.

Another embodiment in which the high-frequency and the intermediate-frequency circuits do not act upon each other is shown diagrammatically in Fig. 2. Similar parts to those in Fig. 1 are indicated by the same reference figures. In this case the high-frequency circuit RF is not a Lecher system, but a tuned circuit constituted by a condenser 15 and two coil halves 16 and 16′ of equal value which are connected to each other by a condenser 17. The intermediate-frequency circuit 10 is constituted by a coil 14 and two condensers 11′ and 11″ of equal value which are connected respectively to the electrodes of the condenser 17. Consequently, the intermediate-frequency circuit is so to speak connected to a tapping of the high-frequency circuit, and the condenser 17 which must have a low impedance for the frequencies of the received oscillations may have such a value that the most advantageous matching of the intermediate-frequency circuit to the diodes is obtained.

A further embodiment is shown diagrammatically in Fig. 3. Similar parts to those in Fig. 1 are again indicated by the same reference numbers. The high-frequency circuit constituted by a Lecher system 9 is connected to the two diode-anodes 3 and 4 via condensers 19 and 20 which for the adjustment of frequency may be variable, if desired, and which have a high-impedance for the intermediate-frequency oscillations, but a low impedance for the high-frequency oscillation. The two extremities of the intermediate-frequency circuit 10 are connected to the two rectifier anodes 3 and 4 via choke coils 21 and 22 which constitute a high impedance for the high-frequency oscillations and a low impedance for the intermediate-frequency oscillations. It is evident that in this circuit, like in that shown in Fig. 2, the currents of the high-frequency and the intermediate-frequency circuits cannot act upon each other so that high-frequency oscillations cannot penetrate into the intermediate-frequency section and intermediate-frequency oscillations cannot penetrate into the high-frequency section.

If desired, the conductors 24 and 25 may also be made as a Lecher system for the high-frequency oscillations, in which case according to the invention the condensers 19 and 20 may preferably be so tuned that the circuit 10 may be connected via the choke coils 21 and 22 to a potential node of the conductors.

Fig. 4, in which similar parts are again indicated by the same reference numbers, shows an embodiment of the invention whose circuit arrangement substantially corresponds to that of the preceding embodiment, but whose construction is different. The intermediate-frequency circuit 10 is here constituted by two cylindrical conductors 26, 27 axially aligned but both concentrically arranged with respect to an outer cylindrical conductor 28 closed at its opposite ends, one end of each of the first-mentioned conductors being connected, respectively, to one of the closed ends of the outer conductor 28.

The high-frequency oscillations received for example by the dipole *c* are conducted by a first Lecher system 9, via condensers 19 and 20 and a second Lecher system 24–25 passing through apertures *a*, *b*, in the outer cylindrical conductor 28 to the diode-anodes 3 and 4. The Lecher system 24–25 is connected at points 26′ and 27′ to the cylindrical conductors 26, 27 of the intermediate-frequency circuit. The points 26′ and 27′ on the Lecher system 24–25 are then so positioned as to coincide with a potential node for the high-frequency oscillations. The points 26′ and 27′ on the circuit 10 are so positioned that the impedance of the part of the circuit 10 between points 26′ and 27′ is a maximum for high-frequency oscillations.

Using an intermediate-frequency circuit of very low damping, it is thus ensured that the intermediate frequency and the high-frequency oscillations remain separated in a highly effective manner.

What we claim is:

1. A frequency changing circuit more particularly for very high frequencies, comprising two diode rectifying systems and an additional electrode system, the cathodes of the three systems being connected to each other for high-frequency currents, circuit elements interconnecting said electrode system for producing local oscillations, a circuit for supplying received high-frequency signal oscillations in push-pull to the two diode rectifying systems, a circuit for deriving the intermediate-frequency oscillations from the two rectifying systems in push-pull, and a circuit constituting a high impedance, at least for the local oscillations used to effect frequency changing, connected between the cathodes and a point of constant potential.

2. A frequency changing circuit as claimed in claim 1 in which the cathodes are connected to the point of constant potential via an inductance coil.

3. A frequency changing circuit as claimed in claim 1, in which the two diode rectifying systems have a common cathode.

4. A frequency changing circuit as claimed in claim 1 in which the diode rectifying system and the local oscillator electrode system are combined in one tube, the cathodes of said systems being connected together inside the tube.

5. A frequency changing circuit as claimed in claim 1, in which the high-frequency signal circuit and the intermediate-frequency circuit are

symmetrically connected relatively to each other.

6. A frequency changing circuit as claimed in claim 1, in which the intermediate-frequency circuit is connected to two symmetrically arranged tappings on the high-frequency signal circuit.

7. A frequency changing circuit as claimed in claim 1, in which the intermediate-frequency circuit is connected to two symmetrically arranged tappings on the high-frequency signal circuit, and said two symmetrically-provided tappings on the high-frequency circuit are shunted by an impedance which is low for the received high-frequency signal oscillations.

8. A frequency changing circuit as claimed in claim 1, in which the intermediate-frequency circuit is connected to two symmetrically arranged tappings on the high-frequency signal circuit, and the intermediate-frequency circuit is tuned by two equal condensers, the extremities of the intermediate-frequency circuit being connected respectively to the two condensers and the other electrodes of the condensers being connected respectively to the tappings on the high-frequency signal circuit.

9. A frequency changing circuit as claimed in claim 1, in which the circuit for the high-frequency signal oscillations is constituted by a Lecher system and the intermediate-frequency circuit is connected to said Lecher system at a point where a potential node for the high-frequency signal oscillations occurs.

10. A frequency changing circuit as claimed in claim 1, in which the circuit for the high-frequency signal oscillations is constituted by a Lecher system and the intermediate-frequency circuit is connected to said Lecher system at a point where a potential node for the high-frequency signal oscillations occurs, and in which the intermediate-frequency circuit is so constructed mechanically that it may be moved to and fro along the Lecher system, the extremities

of the intermediate-frequency circuit making contact with the two Lecher wires.

11. A frequency changing circuit as claimed in claim 1, in which the high-frequency signal circuit is connected to the two rectifying electrode systems via condensers which constitute a high impedance for intermediate-frequency oscillations but a low impedance for high-frequency signal oscillations, whereas the extremities of the intermediate-frequency circuit are connected to the two rectifying electrode systems via circuit elements which have a high impedance for the high-frequency signal oscillations and a low impedance for intermediate frequency oscillations.

12. A frequency changing circuit as claimed in claim 1, in which the intermediate-frequency circuit is constituted by a pair of cylindrical conductors arranged in concentric relation with respect to a third cylindrical conductor, and the points of connection from said pair of conductors to the diode anodes are so positioned that the impedance between these points is high for the high-frequency signal oscillations.

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