

Jan. 9, 1940.

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2,186,544

FREQUENCY CHANGER

Filed April 23, 1937

3 Sheets-Sheet 1

Fig. 1.

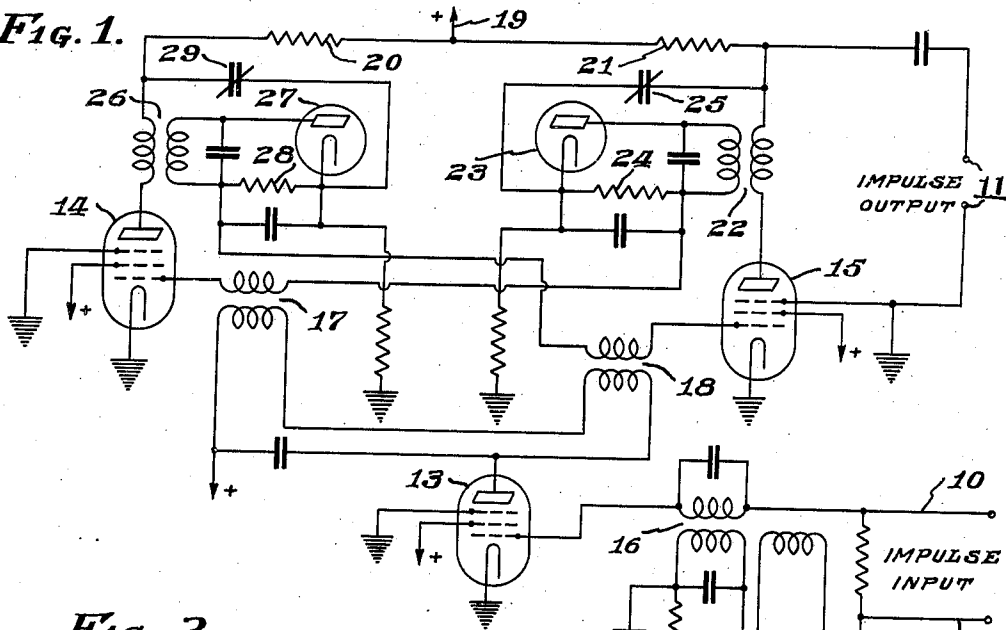
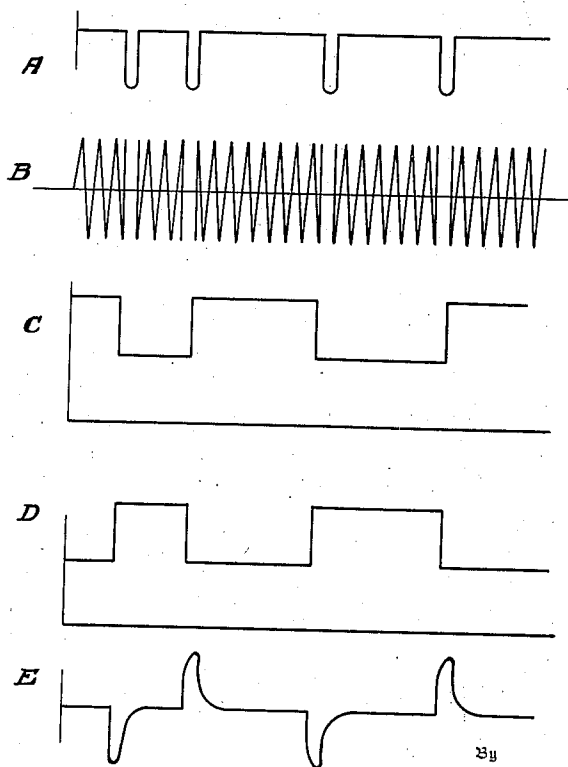


Fig. 2.



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FIG. 3.

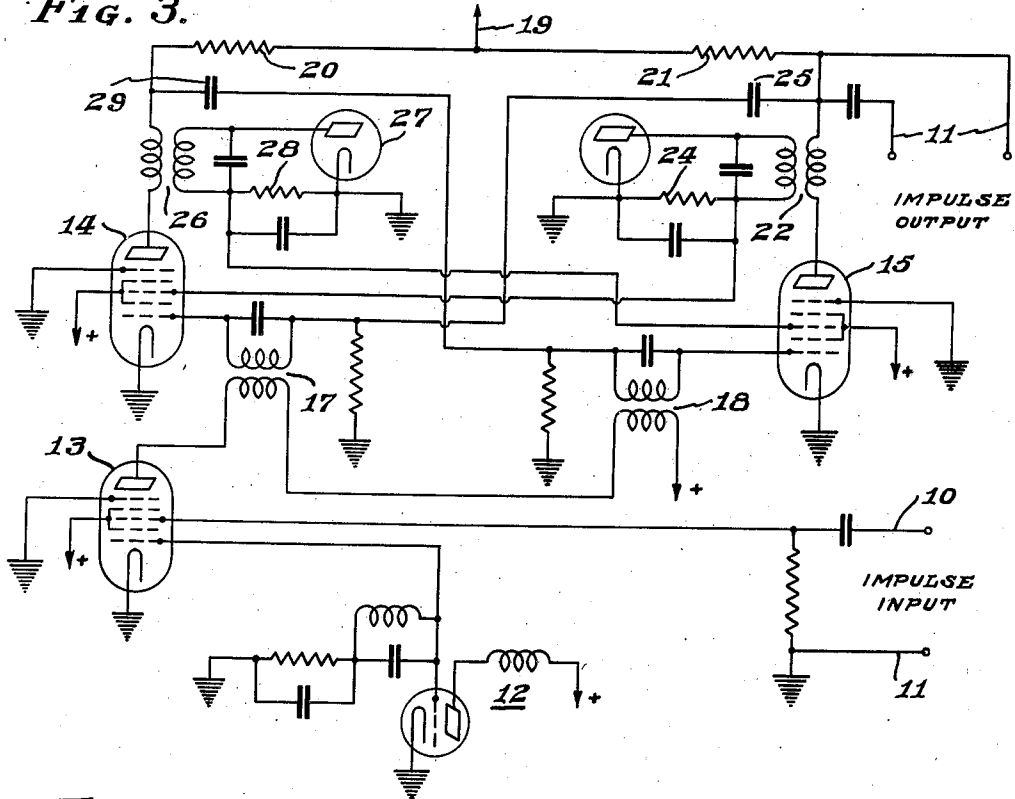
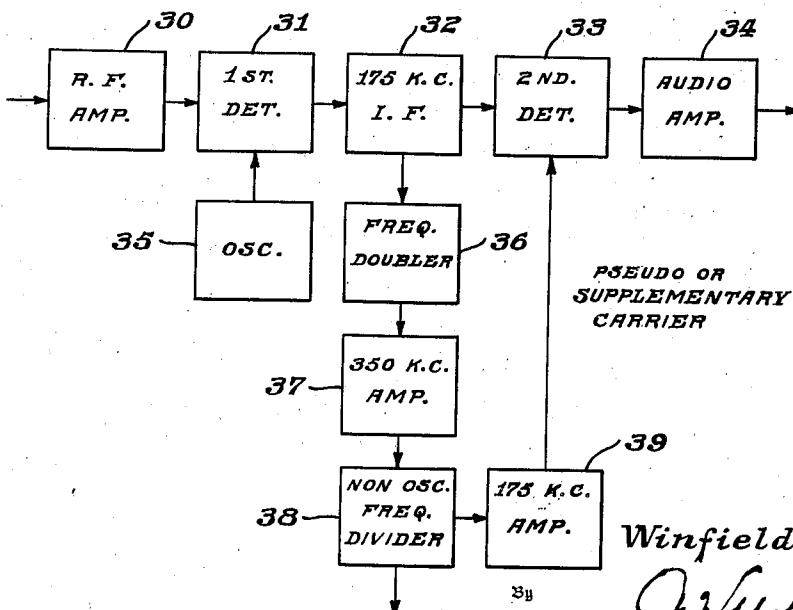


FIG. 4.



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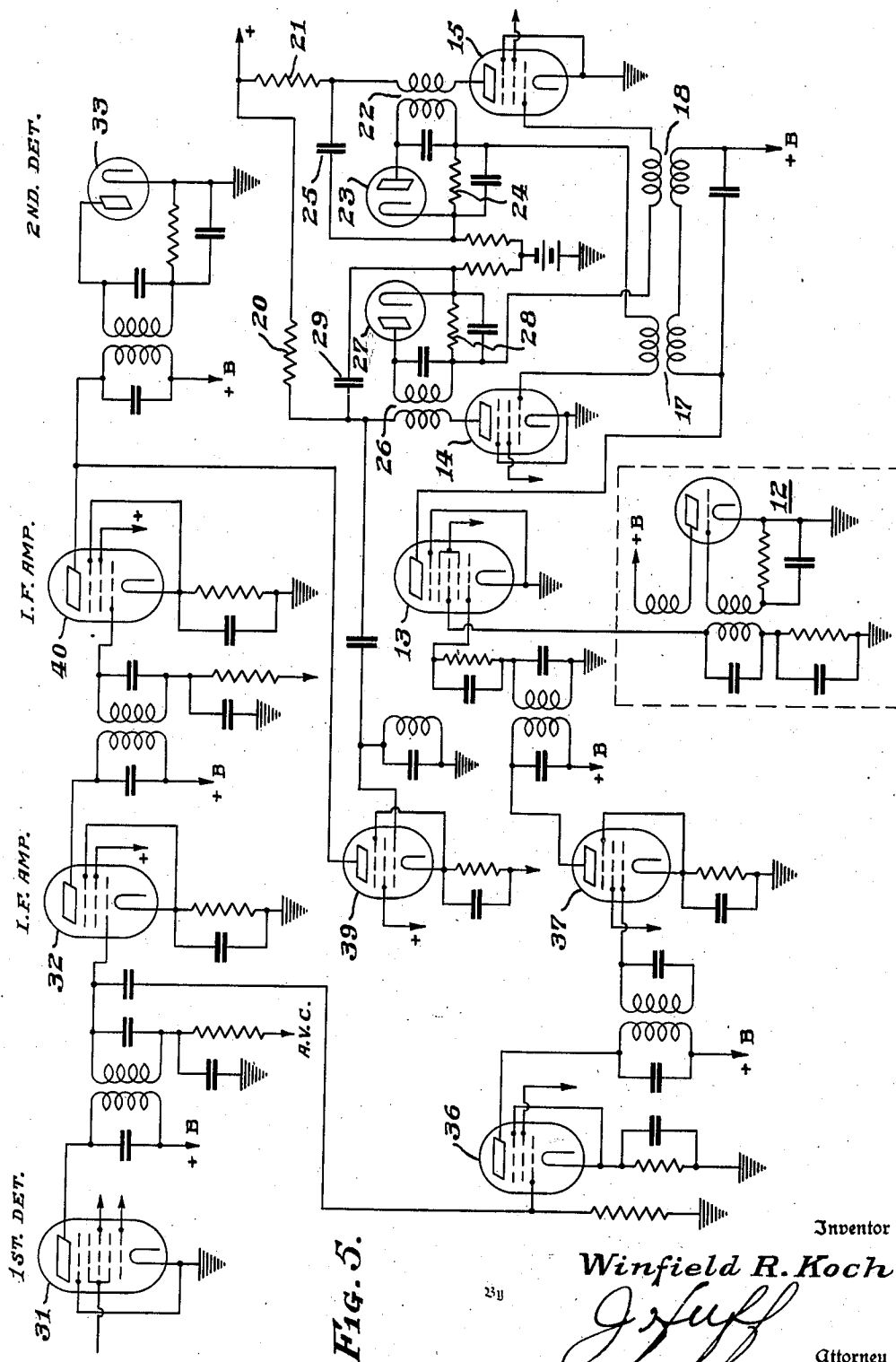
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UNITED STATES PATENT OFFICE

2,186,544

FREQUENCY CHANGER

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Application April 23, 1937, Serial No. 138,553

6 Claims. (Cl. 250-36)

This invention relates to frequency changers, and has for its principal object the provision of an improved frequency changer or divider and method of operation whereby the changing operation is accomplished substantially independently of irregularity in the input or control frequency.

The frequency changer of this invention is susceptible of being used for various purposes such as to control the operation of high speed counters, to prevent selective fading in radio receivers or the like. As applied to the control of high speed counters, it may include a number of similar frequency changer units connected in cascade with one another. As applied to the prevention of fading in radio receivers, selective fading may be controlled by adding the upper and lower side band frequencies to obtain a signal of exactly twice carrier frequency, dividing this frequency by two by means of the device illustrated, and using the impulses of carrier frequency which are thereby obtained to reinforce the faded or suppressed carrier. This method of operation is feasible for the reason that oscillation of the frequency changer is prevented during periods in which no side bands are present. Such periods are likely to occur during the reception of speech. It will be apparent that the improved frequency changer may be used for various other purposes where it is desired to obtain frequency division which is substantially independent of irregularity in the input or control frequency.

The invention will be better understood from the following description when considered in connection with the accompanying drawings, and its scope is indicated by the appended claims.

Referring to the drawings:

Figure 1 is a wiring diagram of one form of the improved frequency changer,

Figure 2 shows a number of explanatory curves relating to the operation of the device of Fig. 1.

Figure 3 is a wiring diagram of a modified form of frequency changer,

Figure 4 is a block diagram illustrating the application of the invention to a radio receiver, and

Figure 5 is a wiring diagram of the radio receiver illustrated by Fig. 4.

The frequency changer of Fig. 1 includes input terminals 10 to which may be supplied negatively polarized control impulses of one frequency, and a pair of output terminals 11 from which may be derived alternating impulses of another frequency, or a D. C. potential which changes with each cycle of operation. Between the terminals 10 and 11 are interposed an independent radio frequency

oscillation generator 12, a radio frequency amplifier 13, and a pair of sharp cut-off amplifiers 14 and 15 which have their input and output circuits so interconnected that when current is supplied to one of the amplifiers the other is biased off in a manner which is comparable to multivibrator action.

It will be observed that (1) the output circuit of the generator 12 is coupled to the input circuit of the amplifier 13 through a transformer 16, (2) the output circuit of the amplifier 13 is coupled through transformers 17 and 18, respectively, to the input circuits of the devices 14 and 15, and (3) plate or anode current is supplied from a terminal 19 respectively through resistors 20 and 21 to the devices 14 and 15.

As will hereinafter appear in greater detail, the control grids of the devices 14 and 15 are subjected to three different potentials. Thus the control grid of the device 14 is subjected (1) to an independent radio frequency potential applied through the transformer 17, (2) to a direct current bias which is dependent on the plate current of the device 15 and is applied through a transformer 22, a detector 23 and a resistor 24, and (3) to a potential which is applied through a condenser 25 and is dependent on the change in potential drop of the plate resistor 21 of the device 15. Likewise the control grid of the device 15 is subjected to three potentials which are supplied respectively through the transformer 18, through the associated transformer 26, rectifier 27 and resistor 28, and through a capacitor 29.

The impulses appearing in the various parts of the apparatus are illustrated by the curves of Fig. 2, wherein the curve A represents the negative half of the impulses applied at the terminals 10, the curve B represents the radio frequency impulses delivered at the output of the amplifier 13, the curve C represents the potential drop of the resistor 21, the curve D represents the potential drop of the resistor 20, and the curve E represents the impulses supplied at the terminals 11.

In the operation of the apparatus of Fig. 1, load current is transferred from one of the amplifiers 14 or 15 to the other on each application of a negatively polarized impulse to the input circuit of the amplifier 13. Thus, assuming the device 14 to be carrying the load, the successive steps of the operation are as follows: The amplified and rectified radio frequency impulses produce in the resistor 28 a potential which biases the device 15 to cut-off. The radio frequency impulses are momentarily interrupted by a nega-

tive lobe of the control impulses. This reduces the potential drop of the resistor 28 and the device 15 starts to open. The potential drop of the resistor 21 operates through the capacitor 25 to increase the negative bias of device 14, thus reducing the potential drop of resistor 20 and causing a higher positive voltage to be applied to the capacitor 23, with operation similar to the well known multi-vibrator circuit. This action continues until the device 14 is biased to cut-off and the device 15 is wide open. Meanwhile, the negative impulse on amplifier 13 ceases, and the radio frequency is again present on the grids of amplifiers 14 and 15. Because amplifier 15 is in operating condition, it amplifies the radio frequency which is then impressed on rectifier 23, and produces in resistor 24 a negative bias voltage for the grid of amplifier 14, keeping it from becoming operative. When the radio frequency impulse is again momentarily interrupted by a negative lobe of the control impulse, the potential drop of the resistor 24 decreases and the device 14 starts to open. The potential drop of the resistor 20 increases and operates through the capacitor 29 to increase the negative bias of the device 15. This causes a decrease in the potential drop of the resistor 21, thus making the grid of the device 14 more positive, and this action continues until the device 14 is wide open and the device 15 is biased to cut-off. The return of the radio frequency locks the amplifiers in this state until the next applied negative impulse.

As indicated above, and as shown by the curves of Fig. 2, this method of operation has the advantage that irregularities or interruptions in the input or control impulses are exactly reproduced in the output impulses of the frequency changer.

The frequency changer of Fig. 3 differs from that of Fig. 1 in that the amplifiers 13, 14 and 15 are of the pentagrid type and the various control potentials are applied to separate grids instead of a single grid. The operation of this modification is similar to that of the arrangement of Fig. 1 and will be readily understood without further explanation.

Fig. 4 illustrates the application of the invention to a radio receiver for reinforcing a carrier which is subject to selective fading or is otherwise suppressed. This receiver includes a radio frequency amplifier 30, a first detector 31, an intermediate frequency amplifier 32, a second detector 33, and an audio frequency amplifier 34. Associated with the detector 31 is the usual oscillation generator 35, and connected between the amplifier 32 and the detector 33 are a frequency doubler 36, an amplifier 37, a frequency changer 38, and an amplifier 39.

In the operation of the radio receiver of Fig. 4, the upper and lower side bands are added together by the frequency doubler 36 to produce impulses of a frequency twice that of the carrier. These double frequency impulses are selected and amplified by the device 37 and are utilized by the frequency divider 38 to produce impulses of carrier frequency which are amplified by the amplifier 39 and supplied to the input circuit of the detector 33 to replace the carrier which has faded out. With the usual type of oscillating frequency divider, difficulty in the operation of this system is encountered for the reason that the short periods between words or the like, when no side bands are present, allow the oscillating frequency divider to drop out of step. Under these conditions, each group or series of

side bands must pull the frequency changer back into step and objectionable distortion is produced. This difficulty is avoided by the frequency changer of this invention for the reason that it does not oscillate during intervals when side bands are not present.

In the wiring diagram of Fig. 5, similar parts are indicated by the same reference numerals as those applied to Figs. 1, 3 and 4, and the details of this figure will therefore be readily understood from the previous explanation. It will be noted that an additional intermediate frequency stage 40 has been included in the circuit of Fig. 5.

I claim as my invention:

1. The combination of a pair of electron discharge devices each provided with input and output circuits, means connecting each input circuit to the other output circuit whereby oscillation takes place, means for applying a radio frequency control potential to said input circuits, and means including a rectifier connected between one of said output circuits and the other of said input circuits for applying to said input circuit a unidirectional potential which is dependent on the radio frequency current of said output circuit, whereby said oscillation is prevented so long as said control potential is applied.

2. The combination of a pair of electron discharge devices each provided with input and output circuits, means for applying an intermittent radio frequency control potential to said input circuits, means including rectifiers connected between each of said output circuits and the other of said input circuits for applying to each input circuit a unidirectional potential which is dependent on the radio frequency current of the other output circuit, and means including capacitors connected between each output circuit and the other input circuit for applying to each input circuit a potential dependent on the change in average current in the other output circuit whereby oscillation takes place between said discharge devices when said radio frequency control potential is not applied.

3. In a device of the character described, the combination which includes a pair of electron discharge devices, means for causing said discharge devices to become alternately conductive, said means including a source of radio frequency currents, means for applying said radio frequency currents to said devices, means responsive to the radio frequency currents in said devices for maintaining one of said tubes in a non-conductive state, and means for momentarily interrupting the application of said radio frequency currents to said devices to cause the other of said discharge devices to become non-conductive.

4. In a device of the character described, the combination which includes a pair of electron discharge devices, means for causing said discharge devices to become alternately conductive, said means comprising a source of radio frequency currents, means for applying said radio frequency currents to said devices, means responsive to the radio frequency currents in one of said devices for maintaining the other of said devices in a non-conductive state, means for momentarily interrupting the application of said radio frequency currents to said devices to cause the other of said devices to become non-conductive, and means coupled to said devices for obtaining an output impulse whose amplitude varies in response to each successive interruption of said radio frequency currents.

5. In a device of the character described, the

combination which includes a pair of electron discharge devices having input and output circuits, means for causing said devices to become alternately conductive, said means comprising a
5 source of radio frequency currents, means for applying said radio frequency currents to the input circuits of said devices, means coupled to the output circuits of each of said devices for rectifying said radio frequency currents to obtain
10 bias voltages the amplitudes of which are respectively determined by the state of conduction of the device to which said means is coupled, means for applying the bias voltage derived from each of said devices to the other of said devices to
15 maintain one of said devices in a non-conductive state, and means responsive to a control impulse for interrupting the application of said radio frequency currents to said devices to cause the other of said devices to become non-conductive.

6. The combination which includes a pair of electron discharge devices provided with input and output electrodes, means for causing said devices to become alternately conductive, said
5 means comprising a source of radio frequency currents, means for applying said radio frequency currents to the input electrodes of said devices, means for applying to the input electrode of each of said devices a uni-directional blocking potential the amplitude of which is dependent upon
10 the radio frequency current flowing to the output electrode of the other of said devices, and means for momentarily interrupting the application of said radio frequency currents to said
15 devices to cause the blocking potential to be removed from one tube and applied to the other.

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