

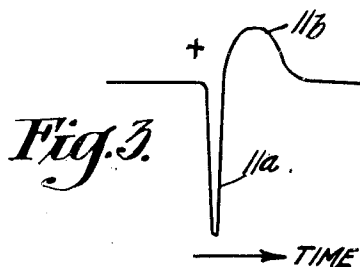
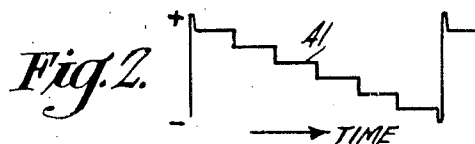
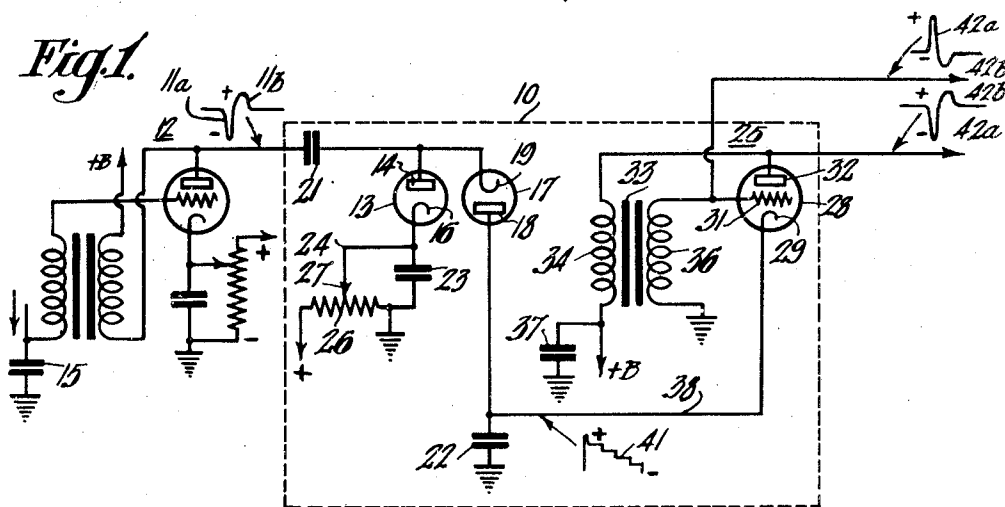
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FREQUENCY COUNTER CIRCUIT

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FREQUENCY COUNTER CIRCUIT

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My invention relates to frequency counter or frequency divider circuits of the type wherein pulses of current are applied through a diode or the like to a storage capacitor so that the voltage across the capacitor changes in steps.

An object of the present invention is to provide an improved counter circuit that is operated by periodically recurring signals or pulses of negative polarity.

A further object of the invention is to provide an improved frequency counter or divider circuit including a blocking oscillator having a two winding transformer from which either positive or negative first occurring pulses may be obtained.

In a preferred embodiment of the invention the storage capacitor of the counter is connected in the cathode circuit of a blocking oscillator that is to be controlled thereby. A pair of diodes are connected so that current pulses flow into the storage capacitor in response to negative input pulses and so that each time said blocking oscillator is triggered the storage capacitor is charged to a predetermined potential. The negative input pulses then lower the capacitor potential in steps until it is low enough to again trigger the blocking oscillator.

Other objects, features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing in which

Figure 1 is a circuit diagram of one preferred embodiment of the invention and Figures 2 and 3 are graphs that are referred to in explaining the operation of the circuit shown in Fig. 1.

Fig. 1 shows a frequency counter enclosed within the rectangle 10 that embodies the present invention. The counter 10 in the example shown has negative input pulses 11a applied to it from a blocking oscillator 12 that produces pulses having the negative portions 11a and the positive portions 11b (Figs. 1 and 3). For the purpose of illustration, it is assumed that the blocking oscillator 12 is part of a conventional counter circuit that has a counter storage capacitor 15 included in the oscillator grid circuit.

My improved counter 10 comprises a diode 13 having an anode 14 and a cathode 16, a diode 17 having an anode 18 and a cathode 19, an input or "bucket" capacitor 21, and a storage capacitor 22. The diode 17 is connected in series with the capacitors 21 and 22 in the polarity required for the negative pulses 11a to apply a charge to the capacitor 22. As in customary counter circuit design, the bucket capacitor 21

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is of small capacity compared with that of the storage capacitor 22.

After each pulse 11a occurs, the resulting charge on the capacitor 21 is removed by the diode 13 which is connected in the polarity required to let this charge flow off. The cathode 16 of the diode 13 is held substantially at ground potential at the pulse repetition rate by means of a filter capacitor 23. The cathode 16 of the diode 13, however, is held at some predetermined direct-current potential, for a reason explained hereinafter, by means of a connection 24 to a potentiometer resistor 26, this potential being adjustable by means of a tap 27.

The other portion of the counter 10 includes an oscillator 25 which preferably is a blocking oscillator comprising a vacuum tube 28 having a cathode 29, a grid 31 and an anode 32. The usual transformer 33 having a primary 34 and a secondary 36 is provided to couple the plate circuit to the grid circuit. The +B end of the primary 34 may be bypassed to ground through a filter capacitor 37.

According to the present invention the cathode 29 of the oscillator tube 28 is connected through a conductor 38 to the high potential side of the storage capacitor 22. The low potential end of the transformer secondary 36 is connected through ground to the low potential side of capacitor 22, the other end of this secondary being connected to the grid of the oscillator tube. Thus, if the high potential side of the capacitor 22 is sufficiently positive, the tube 28 is blocked or biased to cut-off so that it will not oscillate to produce a pulse until the voltage across capacitor 22 is reduced.

The operation of the counter is as follows: The blocking oscillator 25 will oscillate once when power is applied, thus producing a flow of current through the storage capacitor 22 from the oscillator tube cathode 29 to ground. This charges the capacitor 22 to a predetermined potential determined by the setting of the potentiometer tap 27. This predetermined potential will not be exceeded since there will be a flow of current from the capacitor 22 through the diodes 17 and 13 to ground as soon as the positive potential on capacitor 22 exceeds the positive potential at the tap 27. Thus, the oscillator tube 28 is biased to anode current cut-off by the initial positive voltage impressed on its cathode 29 from the storage capacitor 22.

Now when the negative input pulses 11a are applied to the counter through the bucket capacitor 21, the flow of current through the diode 17

into the capacitor 22 is in the direction opposite to the flow of initial charging current from oscillator 25. Therefore, each negative pulse 11a lowers the voltage across the storage capacitor 22, and at the end of each pulse 11a the bucket capacitor 21 is discharged to its original potential through the diode 13.

The above described action produces across the capacitor 22 the stepped voltage wave 41 (Figs. 1 and 2). The tap 27 is adjusted so that a predetermined number of pulses 11a will lower the storage capacitor voltage 41 to a value where the oscillator tube 28 draws anode current. When this happens, the oscillator 25 goes through one oscillation to produce the pulse 42a-42b, and the storage capacitor 22 is again charged to the predetermined positive voltage to bias off the tube 28.

It will be seen that the pulse portion 42a which is positive at the grid 31 may be applied to a load circuit, such as a positive pulse operated counter, without disturbing the operation of the counter 10 since the low potential end of the secondary 36 is grounded.

From the foregoing, it will be apparent that my invention avoids the use of a three-winding transformer for obtaining from a blocking oscillator a first-occurring pulse portion 42a of positive polarity. A pulse of positive polarity is often desired in circuits such as frequency divider chains. In former circuits an interwinding transformer leakage of the order of 100 megohms sometimes was detrimental to proper counter operation. The undesirable effects of such leakage are avoided by the present invention. Also, in the present circuit the net oscillator plate voltage is nearly the full +B voltage rather than the +B voltage minus the cathode bias voltage as in other counter circuits, and this full +B voltage is not changed when adjustments of the potentiometer tap 27 are made for the purpose of adjusting the count.

It should be understood that the invention is not limited to the use of an oscillator of the type described although the invention is particularly useful when a blocking oscillator is employed. However, the blocking oscillator may be replaced by a multivibrator or the like if desired.

I claim as my invention:

1. A frequency counter comprising a bucket capacitor, a unilateral conducting device and a storage capacitor connected in series with each other, said device being connected in the polarity required for a negative input signal to cause current flow into said storage capacitor when said signal is applied to said bucket capacitor, a source of bias or control voltage and a second unilateral conducting device connected between a positive point on said bias source and the junction point of said bucket capacitor and said first device, said second device being connected in the polarity required to discharge said bucket capacitor at the end of each negative input signal, and an oscillator comprising a vacuum tube having a cathode connected to the junction point of said storage capacitor and said first device whereby said oscillator charges said storage capacitor to bias said vacuum tube to cut-off each time the oscillator oscillates.

2. A frequency counter comprising a bucket capacitor, a unilateral conducting device and a storage capacitor connected in series with each other, said device being connected in the polarity required for a negative input pulse to cause current flow into said storage capacitor when said

pulse is applied to said bucket capacitor, a source of bias or control voltage and a second unilateral conducting device connected between a positive point on said bias source and the junction point of said bucket capacitor and said first device, said second device being connected in the polarity required to discharge said bucket capacitor at the end of each negative input pulse, and a blocking oscillator comprising a transformer having a primary and a secondary and further comprising a vacuum tube having a cathode connected to the side of said storage capacitor which is connected to said first device and having anode and grid circuits coupled through said transformer, one end of the secondary of said transformer being connected to the grid of said vacuum tube, and the other end of said secondary being connected to the other side of said storage capacitor.

3. In combination, a blocking oscillator comprising a vacuum tube having an anode, a control grid and a cathode, a storage capacitor through which said cathode is connected to ground, a bucket capacitor and a unilateral conducting device connected in series with each other and said storage capacitor, said device being connected in the polarity required to reduce a positive charge on said storage capacitor in response to the application of a negative input pulse to said bucket capacitor, and a second unilateral conducting device and a voltage bias source connected in series with each other and connected between ground and the junction point of said bucket capacitor and the first device, said bias source being connected in the polarity required to limit the positive charge on said storage capacitor, and said second device being connected in the polarity required to discharge said bucket capacitor at the end of each negative input pulse.

4. In combination, a blocking oscillator comprising a vacuum tube having an anode, a control grid and a cathode, a storage capacitor through which said cathode is connected to ground, a bucket capacitor and a diode connected in series with each other and said storage capacitor, said diode having its anode connected to said storage capacitor whereby a positive charge on said storage capacitor is reduced in response to the application of a negative input pulse to said bucket capacitor, and a second diode and a voltage bias source connected in series with each other and connected between ground and the junction point of said bucket capacitor and the first diode, said bias source being connected in the polarity required to limit the positive charge on said storage capacitor, and said second diode having its anode connected to said bucket capacitor whereby said bucket capacitor is discharged at the end of each negative input pulse.

5. In combination, a storage capacitor, a charging or bucket capacitor, a unilaterally conducting device connected between one plate of each of said capacitors for admitting current from said charging capacitor to said storage capacitor, a second unilaterally conducting device and a voltage bias source in series with each other and connected between the junction of the charging capacitor and the first-mentioned conducting device and the other plate of said storage capacitor for discharging said charging capacitor and for limiting the charge on said storage capacitor, said bias source being connected in the polarity required to oppose current flow through said second conducting device, means for impressing a pulsating current between said other plate of the storage capacitor and the other plate of the

charging capacitor, and means comprising an oscillator connected across the storage condenser for charging the storage capacitor following a predetermined reduction in the charge thereon by said pulsating current.

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