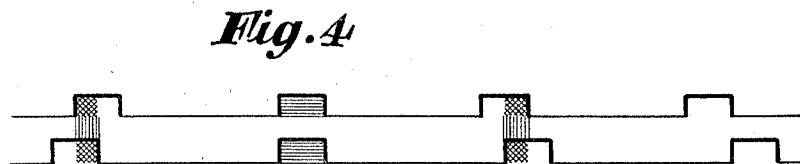
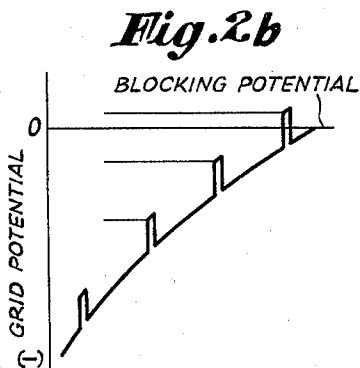
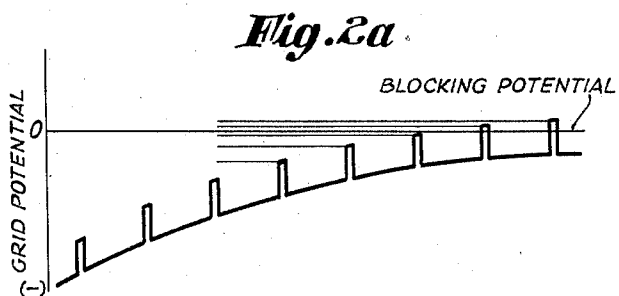
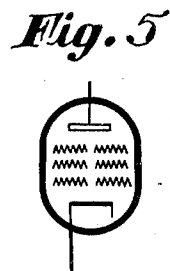
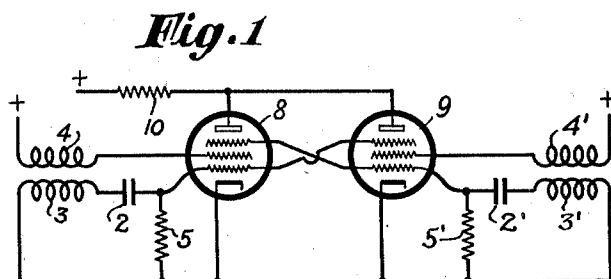
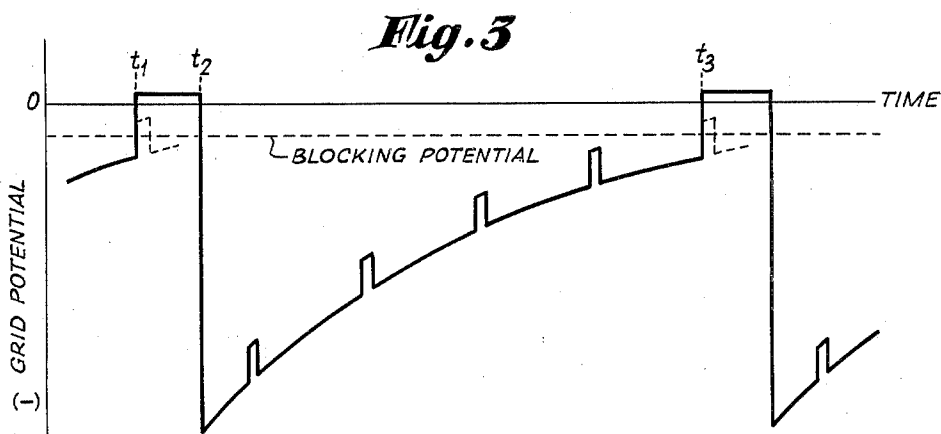


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OSCILLATOR CIRCUITS

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Circuit organizations may be employed for frequency division in which blocking oscillators or multivibrators are synchronized by impulses in such a way that an oscillatory process is produced by each n th rather than by each and every impulse; in other words, that the frequency of the blocking oscillator or multivibrator under consideration is a subharmonic and is the n th part of the frequency of the synchronizing impulse sequence.

According to the invention a circuit arrangement is disclosed which consists of a combination of two or more such blocking oscillators or multivibrators and which represents a coincidence arrangement designed to furnish a signal only when in the two blocking oscillators operating at dissimilar frequencies a signal just happens to be produced at the same time.

The invention may best be understood by referring to the drawing, wherein like reference numerals indicate like parts and wherein:

Figure 1 shows one form of the present invention;

Figures 2a, 2b and 3 show curves of control grid potential as a function of time;

Figure 4 shows the relationship of two impulse series, and

Figure 5 shows a form of discharge tube which may be used in the modification shown in Figure 1.

The operation of a blocking oscillator is well known in the art and examples of blocking oscillators are to be found in U. S. patents to Geiger Nos. 2,157,533, 2,159,792 and 2,193,868.

Now, a preferred form of circuit organization according to the invention shall be explained by reference to Figure 1. The two pentodes 8 and 9, each by itself, are included in the organization of a blocking oscillator; but the screen grids play here the part usually played by the plate. Moreover, the grids are connected crosswise in the following fashion: Control grid of tube 8 with the suppressor grid of tube 9; suppressor grid of tube 8 with the control grid of tube 9. The oscillatory circuit is preferably connected with the (suppressor or control) grid whose drive range is the greatest. As a general rule, care must be taken so that the two control grids of a tube possess approximately the same drive range. However, it will also be sufficient if the two inter-connected grids which do not form part of the same tube, have approximately the same drive range. The plates of the two tubes are connected with each other and they work upon a common resistance 10.

If the tubes 8 and 9 oscillate at dissimilar frequencies, then it will be evident that at the joint plate of both tubes an impulse will be able to arise only if in both tubes, just at one and the same time, both grids are opened up; in other words, when two impulses of dissimilar impulse sequences happen to coincide. The frequency of the impulses arising across resistance 10 is the highest joint multiple of the frequencies at which the two blocking oscillators 8 and 9 are excited. If these frequencies have dissimilar divisors, then the coincidence frequency will be equal to unity; if the frequencies are fractional numerals with dissimilar denominators (say, $\frac{1}{5}$ or $\frac{1}{7}$) then the coincidence frequency will be their maximum common multiple (that is, in this instance $\frac{1}{35}$).

In connection with the method described by reference to Figure 3 for frequency division, fundamentally speaking, all integer division ratios are imaginable. However, for safety's sake of the arrangement it will be advisable in practice to not go beyond a division around the factor 10. The higher the division ratios are chosen, the flatter will be the exponential rise of the grid potential, and the less difference will there be in the crests or peaks of the impulses imposed upon the voltage shape as regards their distance from the blocking potential so that, in the presence of slight fluctuations in the operating data, it may happen that the impulse preceding the desired impulse may cause firing, or else the subsequent impulse may cause this (see Figure 2a). The steeper the grid voltage shape, that is to say, the lower the division ratios, the safer and the more dependable will be the operation of the arrangement (Figure 2b).

A coincidence arrangement of the kind described by reference to Figure 1 permits the extension of the division ratio to a further degree. While it is true that what has been set forth applies equally to the individual blocking oscillators, it will be noticed that in a coincidence circuit organization the two ratios are multiplied with each other. Suppose, for instance, that both blocking oscillators are synchronized by one and the same frequency. Tube 8, because of the dimensions chosen for the resistance-capacity combination in the grid circuit, responds to each eighth, and tube 9 to each ninth, impulse; then across resistance 10 the original or primary frequency has been reduced to one seventy-second. In order to preclude the chance of undesirable coincidences which may conceivably be due to the fact that the rear portion or tail of an impulse produced in a tube is in time coincidence

with the front of an impulse produced in the other tube as indicated in Figure 4, it will suffice to choose the impulse duration (time interval t_1-t_2 , Figure 3) at about one-tenth the whole period; for no division ratios greater than 1:10 are generally met with in practice.

The circuit organization shown in Figure 1 may be further simplified by using a special type of tube in lieu of the two separate tubes 8 and 9. The electrode assembly of such unitary tube, basically, should be chosen in a way as shown in Figure 5. This tube, besides a filament and a plate, has two distinct grid systems; each of the latter consists of at least three grids, say, control, screen and suppressor grid or else a second control grid. It would also be conceivable to use more than three grids; but two thereof should roughly possess the same drive range. In a special case, two electrodes serving as control grids could be inter-connected crosswise, though this is not essential. It is to be noted that what has been set forth above in connection with blocking oscillators applies, so far as the invention is concerned, equally also to multivibrators.

I claim:

1. A system for producing frequency division comprising a pair of discharge tubes each having a cathode, a control electrode, a screen grid electrode, a suppressor electrode and an anode, means for connecting the control electrode of each tube to the suppressor electrode of the other tube, means including a pair of resistances each for connecting a control electrode to the associated cathode of each tube, two pairs of mutually coupled inductances, means including a condenser for connecting one inductance of each pair in parallel with each of said resistances, means for connecting the other inductance of each pair between a source of positive potential and the screen grid electrode of each tube so that neither tube passes current from anode to cathode unless both are permitted to so pass current, and an anode circuit including a single impedance for maintaining both anodes positive with respect to the cathodes, whereby the frequency of the current present in the anode circuit will be a sub-multiple of the frequency applied individually to the control electrodes of each of the tubes.

2. A system for producing frequency division comprising a pair of independently operating blocking oscillators, each oscillator comprising a discharge tube having a cathode, a control electrode, a screen grid electrode, a suppressor electrode and an anode, and each oscillator including means whereby the control electrode and the screen grid electrode of each tube are inductively coupled to each other, means for connecting the control electrode of each tube to the suppressor electrode of the other tube so that neither tube conducts anodic current unless both tubes are in the same condition, and a common anode circuit including a single load impedance for maintaining the anodes positive with respect to the cathodes whereby the time period for each cycle of the frequency appearing in the anode circuit will be the reciprocal of the difference between the frequencies of operation of the two blocking oscillators.

3. A system for producing frequency division comprising a pair of discharge tubes each having a cathode, a control electrode, a screen grid electrode, a suppressor electrode, and an anode, means for connecting the control electrode of each tube to the suppressor electrode of the other tube whereby neither tube will conduct current from anode to cathode unless both are in the same condition, means including a pair of resistances each for connecting a control electrode to its associated cathode, further means including a series arrangement of a condenser and an inductance connected in parallel with each resistance, a second pair of inductances each connected between a source of potential and the screen grid electrode of each tube, each of said second pair of inductances being individually positioned in mutual inductance relationship with respect to the inductance in the grid circuit of each tube respectively, whereby each tube may operate independently as a blocking oscillator, and a common anode circuit including a single impedance for maintaining each anode positive with respect to the cathodes whereby the frequency appearing in the anode circuit of the tubes will be the sub-harmonic beat frequency of the frequencies at which the tubes independently operate.

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