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CIRCUIT ARRANGEMENT FOR GENERATING OR AMPLIFYING ELECTRIC OSCILLATIONS

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Fig. 1

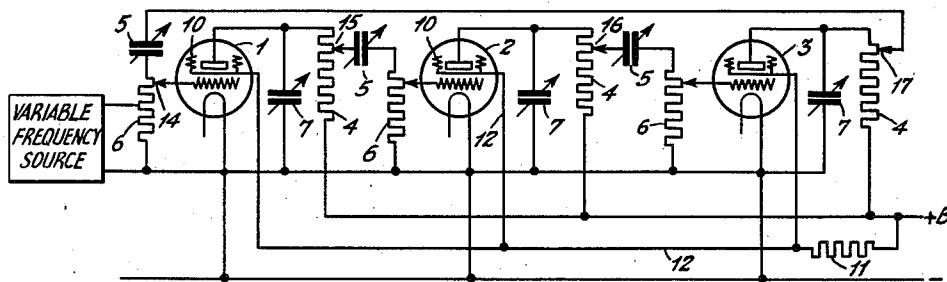


Fig. 2

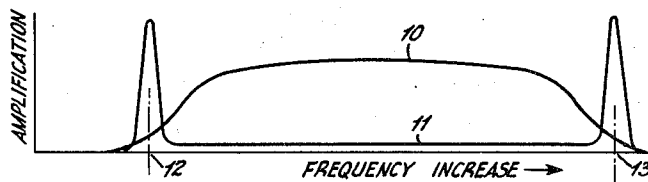
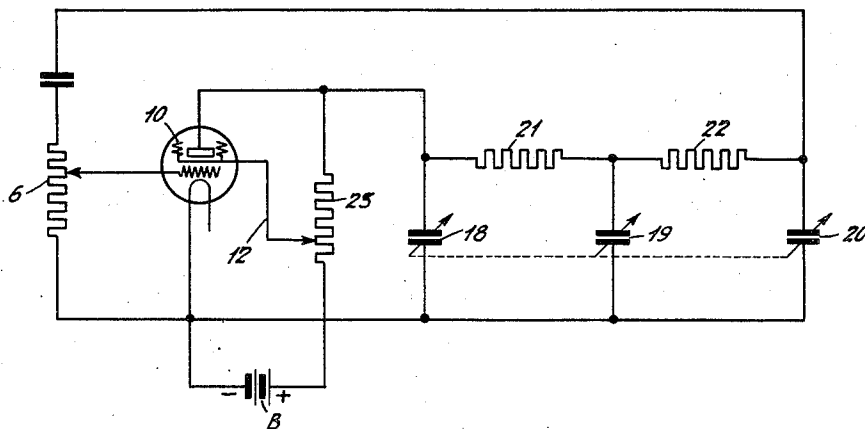


Fig. 3



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CIRCUIT ARRANGEMENT FOR GENERATING
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TIONSBalthasar van der Pol and Jan van der Mark,
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7 Claims. (Cl. 179—171)

The invention has reference to a circuit arrangement for generating or amplifying electric oscillations which is adapted for use in a wireless receiving or transmitting set, in devices for transmitting or receiving picture telegraphy or television or the like, generally therefore in devices in which oscillations of a given frequency are selectively amplified or generated.

The desired selectivity is generally obtained by the use of circuits tuned by means of inductances and capacities. In the circuit arrangement according to the invention either inductance coils and resistances or capacities and resistances are used, reaction being provided for in a determined manner so that nevertheless the properties of a circuit comprising inductance and capacity with reaction are obtained.

According to the invention, a circuit arrangement for generating or amplifying electric oscillations includes one or more thermionic valves the output circuit or circuits of which includes or include a combination either of resistances and capacities or of resistances and inductances which jointly bring about for the desired frequency range a phase displacement of 180° , a reaction being provided for which is so strongly negative for a frequency for which no phase displacement occurs that a voltage of that frequency is not amplified.

In order that the invention may be clearly understood and readily carried into effect two embodiments thereof will now be described more fully, by way of example, with reference to the accompanying drawing, in which

Figures 1 and 3 show diagrammatically circuit arrangements according to the invention; and,

Figure 2 shows a characteristic curve of amplification for explaining the action of the said circuit arrangements.

Referring to Figure 1, 1, 2 and 3 designate thermionic valves each of which is coupled to the next valve by means of a resistance 4 and a condenser 5. In addition, grid leaks 6 are provided and capacities 7 are connected in parallel with the resistances 4. By making the grid connections to resistors 6 adjustable, the alternating voltages applied to the respective grids may be adjusted at will. If desired screen grids 10 may be employed in the valves to reduce the capacity effect between the anodes and control grids, and the grids 10 may be connected to the B battery or other positive voltage source through a resistor 11 and leads 12. In certain cases when using triodes, the anode-cathode capacities of the

valves may replace condensers 7 but in this case the advantage of their adjustability is lacking.

As is well known, such a resistance amplifier yields for a given range of frequencies a substantially uniform amplification. For lower frequencies the amplification decreases as a result of the presence of the condensers 5 and resistances 6 and for higher frequencies the decrease in amplification is due to the capacities 7 and the resistances 4 since these impedances bring about for given frequencies a certain phase displacement which results in a decrease in amplification.

The grid filament capacity and the grid anode capacity of the valves affect the characteristic curve of amplification. Usually, screen grid valves are used or some well known means are resorted to in order to neutralize the influence of the anode grid capacity.

In the well known resistance amplifying circuit arrangements, care is always taken that the frequency band for which the phase displacement is so great that the amplification is reduced to half the maximum amplification falls outside the range of frequency to be amplified. In contrast to this, according to our invention the occurrence of phase displacements for given frequencies is used for securing a selectively acting set. For this purpose the resistances and condensers should be such that, apart from the phase reversion brought about by the valves, for the desired frequency occurs at a given point of the circuit arrangement a voltage phase displacement of 180° relatively to the phase of the voltage in or applied to the input circuit of the first valve. Now, if a reaction is provided for acting from the said point on the input circuit of the first valve and if for the frequencies which originally were amplified to the maximum value this reaction is rendered so highly negative that the said amplification is reduced to practically naught, a sharp maximum value of the amplification will occur for the frequencies for which the phase displacement is exactly 180° .

Referring to Figure 2, 10 shows the characteristic curve of amplification of a resistance amplifier as shown in Figure 1, reaction being not provided for. Now, if a highly negative reaction is provided for in the correct manner, the amplification for that part of the frequencies for which the amplification is substantially constant will be highly reduced. High maximum values occur, however, for the frequencies 12 and 13. They are the frequencies for which the phase displacement was 180° .

Generally, a high amplification is only desired for one given frequency. In this case care can be taken that the second maximum value falls outside the range to be amplified or again a higher damping may be used for the undesired frequency.

As each combination of resistance 4 and capacity 5 can only bring about a phase displacement which is smaller than 90° , a combination of ohmic resistance and capacity is required at least three times to secure a phase displacement of 180° . In the case of Figure 1 it will therefore be necessary to provide for a reaction acting from the output circuit of the third or a subsequent valve on the input circuit of the first valve. The reaction is obtained in the given case by means of a conductor 8 and condenser 5. The number of valves used should always be odd if a negative reaction is to be obtained.

The condensers 7 and/or 8 may be variable so that the frequency to be amplified is regulable. As this frequency depends on the product RC, the variation in capacity exercises a much greater influence with this circuit arrangement than when using tuned circuits in which case the frequency depends on LC. This ensures the advantage that it is possible to regulate throughout a much wider range of frequency with a given size of condenser without the exchange of tuning elements being necessary.

It is also possible to obtain variation in frequency by altering the value of the resistances used.

The value of the reaction will preferably be regulable. In the example shown this is effected by carrying to the input circuit part of the voltage occurring in the resistance 4. As shown, a contact or slider 17 is adjustable along the turns of resistor 4. The resistors used are preferably of the non-inductive type especially when the tuning means employed are condensers, as 7 and 8. It is also possible to obtain a regulation of the reaction by connecting the grids of the valves to a variable point of resistances 6 as shown.

As an alternative, the reaction may be regulated by rendering variable the grid bias of one or more of the valves. When used as an amplifier for a narrow band of frequencies, a source of variable frequency energy such as the antenna of a radio or television receiver may be connected in any preferred manner across the resistor 6 of the first stage. The receiver is adapted to amplify radio frequencies such as are in use in radio broadcasting and also lower radio frequencies.

The reaction may be increased to such extent that the system goes into free oscillation. If in this case the coupling elements between the valves equal each other entirely, there will be for the frequency generated exactly a phase displacement of 120° between the points 14, 15; 15, 16 and 16, 14. Thus, a three-phase current generator is therefore obtained.

Figure 3 shows a further embodiment of the invention in which the output circuit of the amplifier valve includes a number of resistances and capacities which jointly bring about for the desired frequency a phase displacement of 180° . This phase displacement is obtained here by the condensers 18, 19 and 20 in conjunction with the plate impedance of the amplifying valve and the resistances 21 and 22. The condenser 18 has connected in parallel with it a resistance 23 which serves as a direct current path for the anode current from battery B. A partial rotation of the condensers 18, 19 and 20 which may be mounted

on a single spindle as indicated by the dotted line or again a partial rotation of one or more of these condensers results in a variation of the natural frequency transmitted to the output circuit of the amplifier. A screen grid 10 may be used in this form of the invention if desired.

This system will allow particularly the higher frequencies such as radio frequencies to be amplified in a satisfactory manner. If it is desired to amplify low frequencies it will be necessary to use series condensers and parallel resistances.

Again, this system may be constructed as an amplifier or as an oscillator in accordance with the value of the reaction which in this case is varied by shifting the point of connection of the grid of the valve to a resistance 6. When used as an amplifier the signal voltage may be applied to the grid circuit in the manner shown in Fig. 1.

Each of the systems indicated includes only three resistance-capacity combinations. This number may be increased at will, it being of course necessary in such case to vary the dimensions of the condensers and/or of the resistances so that the total phase-displacement for the desired frequency is again 180° . As an alternative, three or more resistance-inductance combinations may be used, the inductances being preferably variable to produce the desired phase displacement of 180° .

Preferably care will be taken that each of the resistance-capacity or resistance-inductance combinations brings about a substantially identical phase-displacement, as in this case the frequency band that can be amplified or generated is as wide as possible.

The condensers and resistances of the circuit arrangements described need not be exactly equal to each other. It is only essential that for any desired frequency a total phase-displacement of 180° can be adjusted. This introduces therefore a high simplification in the manufacture of the condensers.

We claim:

1. An electrical device comprising a vacuum tube having a cathode and plate and input and output circuits and a screen grid, means for impressing a positive voltage on said screen grid, a variable condenser having one side directly connected to said plate and its other side directly to the cathode of said tube and a resistor and condenser in series connected in shunt to said variable condenser.

2. In a device of the class described, the combination of three vacuum tubes, each having a cathode, grid and plate, means for impressing radio frequency signal currents across the grid and cathode of the first stage, a high resistance connected between the plate and cathode of each of the other stages, a condenser shunted across each of said resistances, said condensers being designed to limit the high frequency currents in the output circuit of the third stage, a reactor connected between a point on said resistance and the grid of the succeeding stage and a reactor connected between a point on the resistance in the plate circuit of the third stage and the grid of the first stage.

3. In an amplifying device, the combination of a vacuum tube having a cathode, a control grid and a plate, a resistor connecting said grid and cathode, means for applying a positive potential to said plate, a series circuit connecting said plate and grid and comprising two resistors and a reactor, and two condensers connected in series

across the ends of each of said last named resistors.

4. The combination defined in the preceding claim in which said condensers are equal and a uni-control operating means for adjusting said condensers.

5. In an amplifying device, the combination of a vacuum tube having a cathode, grid and plate, an input circuit connecting said cathode and grid and including a resistor, a plate circuit connecting said plate and cathode and including a plurality of similar filter networks so designed that a point in one of said networks has voltage variations substantially 180 degrees out of phase with the grid voltage and a condenser having one

side directly connected to said point and its other side directly to said grid.

6. The combination defined in the preceding claim in which each filter network comprises two similar variable condensers, a direct connection between one side of each of said condensers and said tube cathode and a uni-control operating means for adjusting said condensers.

7. The combination defined in claim 2 in which the values of the high resistances and reactors are so related that the reaction applied to the grid of the first stage is 180 degrees out of phase with the applied signal voltage.

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