

Dec. 31, 1940.

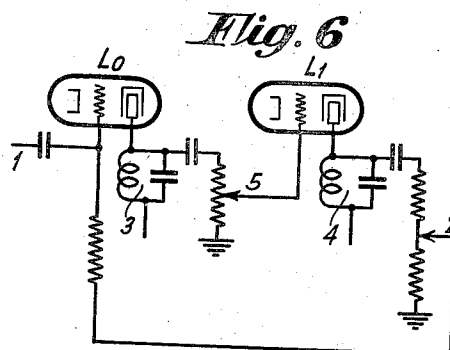
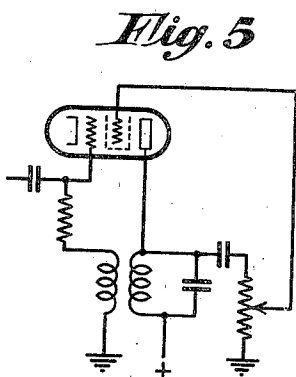
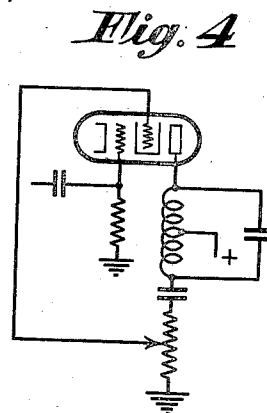
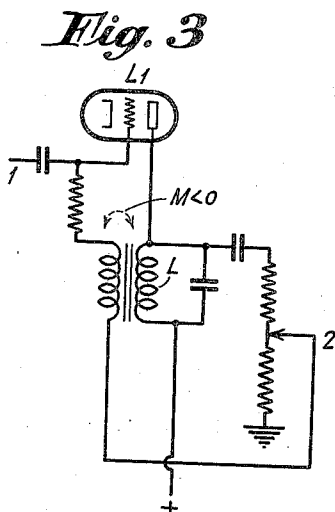
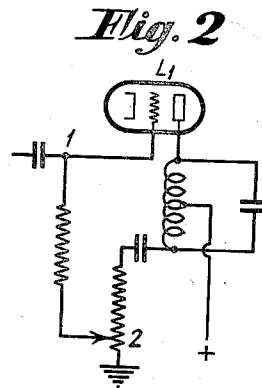
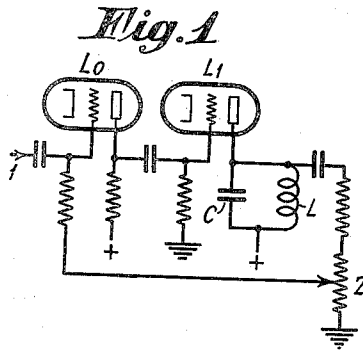
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2,226,945

AMPLIFIER AND OSCILLATOR VALVE OR TUBE

Filed Dec. 28, 1936

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 7

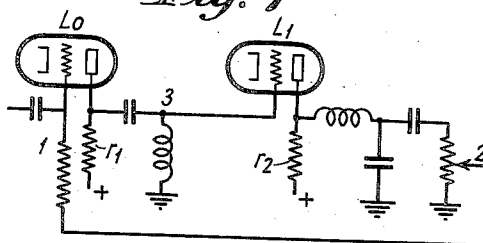


Fig. 8

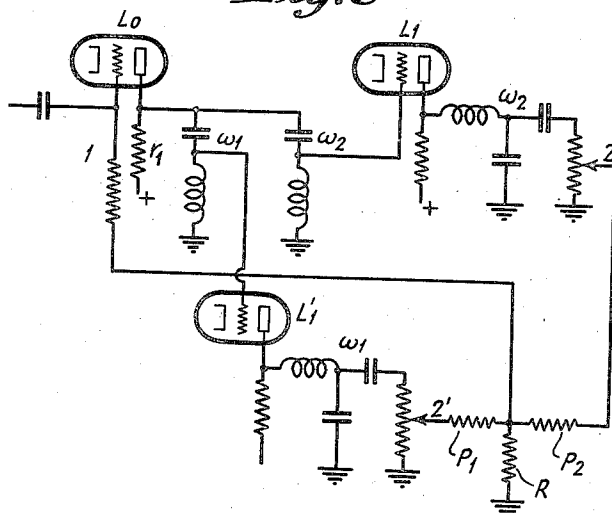
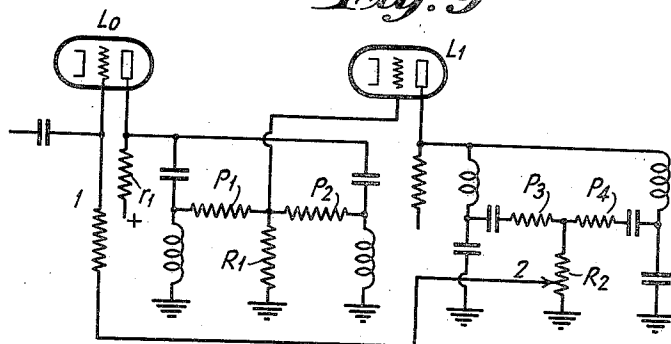


Fig. 9



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AMPLIFIER AND OSCILLATOR VALVE OR TUBE

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Application December 28, 1936, Serial No. 117,909
In France December 26, 1935

1 Claim. (Cl. 179—171)

(Granted under the provisions of sec. 14, act of March 2, 1927; 357 O. G. 5)

This invention is concerned with reaction type amplifiers and with oscillators. Its greatest usefulness is in the audio-frequency field, although it is by no means limited to this case so far as its utility is concerned.

The invention consists, on the one hand, of circuit organizations designed to insure a gradual reaction or regeneration by way of resistance variation, and this results in a very stable and progressive regulation, with the incidental action upon the frequency being minimized, while, on the other hand, it consists of improved methods adapted to insure an in-phase reaction upon the working frequency and a reaction dephased a quantity rapidly reaching the 180-degree limit, in other words, a degeneration or anti-regeneration as soon as the working frequency is departed from.

The invention naturally applies to all regenerative devices, for instance, to selective amplifiers, but also to oscillators, super-regeneration arrangements, etc.

The following figures shown in the drawing will help to explain more clearly the nature of the invention, both as to principle and preferred embodiments thereof. In the drawings,

Figure 1 illustrates a feedback arrangement in accordance with the invention wherein the feedback is from the output of a tube to the input of a preceding tube;

Figure 2 shows in schematic form the invention applied to a single tube;

Figure 3 illustrates a type of controllable feedback wherein fixed feedback of one type is provided and compensated to any desired degree by feedback of another type;

Figure 4 illustrates the invention applied to a single tube wherein the input is to one grid and the feedback to another;

Figure 5 illustrates the type of feedback control shown in Figure 3 except that a multi-element tube is used;

Figure 6 shows the invention applied to an arrangement which includes two tuned stages;

Figure 7 is a schematic diagram of a circuit embodying the invention and using series resonant circuits;

Figure 8 illustrates a circuit presenting selective amplification for more than one frequency; and,

Figure 9 shows in schematic form an arrangement having similar properties as that shown in Figure 8 but using only a single tube for producing the selectivity amplification for two or more frequencies.

In these figures, elements such as resistances, inductance coils, condensers, cathodes, grids, and anodes or plates of three-electrode tubes and tubes with a larger number of electrodes do not always bear a reference letter or numeral, but are merely indicated by the conventional symbols, for this will be found sufficiently explicit for the man trained in this art.

Fig. 1 shows an arrangement in which across the terminals of a tuned output circuit LC, in the plate of a tube L_1 a voltage 2 is obtained by the aid of a high-ohm potentiometer. This voltage 2 is necessarily in phase with the plate voltage of the said tube L_1 so that, if this voltage were fed back again to the grid of the same tube, there would, at least for the resonance frequency and frequencies adjacent thereto, be produced an anti-regenerative action. If tube L_1 is preceded by a resistance stage L_0 mounted in a way as shown in the figure, then the voltage fed back in series with the input voltage 1 would result in a positive reaction or regeneration, that is to say, this would raise the amplification at resonance and also the selectivity.

Pushing regeneration, by a simple increase in the potential 2 by the aid of the potentiometer shown in the drawings, oscillating would be initiated at a frequency far closer the resonant frequency of circuit LC than in the conventional regeneration schemes known in the prior art in which the regeneration impedances by way of coupling invariably introduce stray capacities into the oscillatory circuit. It is moreover evident that the circuit organization may be simplified by the use of a single tube comprising at the same time the constitutive elements of tube L_0 as well as those of tube L_1 , such as a triode-pentode which is known in the modern art.

Fig. 2 shows a modification in which, by the use of an oscillatory circuit, with a high-voltage midpoint in the inductance coil, there results at 2 a regenerative voltage being in phase opposition to the plate potential, this potential being then directly applicable with the input potential 1 to the grid of the single tube L_1 .

Fig. 3 illustrates another modification in which the reaction voltage 2 is in phase with the plate potential and is thus used to diminish by a regulable amount the voltage being in phase opposition impressed upon the grid by coil L_2 having a negative mutual inductance coefficient in reference to inductance coil L. By thus adding to the constant an unduly powerful reaction an anti-regeneration or degenerative action which is variable by resistance, the identical results will be

obtainable as with the arrangements shown in Figs. 1 and 2.

In all of these arrangements the impedance receiving the input potential I may be dispensed with, and what thus results are oscillators whose oscillating is smooth, gradual, and readily regulable.

Fig. 4 shows another modified arrangement in which the regenerative potential is fed back to a different grid than the one on which the input voltage is impressed, the ensuing operation being self-explanatory.

Fig. 5 shows a modified circuit scheme in which the regenerative potential and the degenerative potential are brought to two distinct grids.

All arrangements which have just been described, operate extremely satisfactorily as oscillators. When used as regenerative amplifiers, the inherent advantage flows from the fact that they permit a very gradual regulation without any appreciable action upon the resonance frequency. But if, for instance, the circuit scheme Fig. 1 is examined it will be seen that if the resonance state is departed from, the regenerative voltage instead of presenting phase 0 to the plate potential, has a phase which rather tends towards the value

$$\pm \frac{\pi}{2}$$

when working with frequencies which are far higher or far lower. Further, the value of the voltage itself is reduced, which is useful; however, this value is reduced more and more as the Q of the circuit is less and less; in other words, it is more and more difficult to improve, by way of reaction, the selectance of a circuit, as the quality of this circuit is lower in the absence of regeneration. It will be obvious that if conditions could be made so that the phase shift of the reaction voltage attains, or tends towards the value $\pm \pi$ for frequencies far removed from resonance, there would then arise anti-regeneration which, to a considerable degree would improve selectance.

The following figures show arrangements in which the said property has been incorporated.

Fig. 6 shows an arrangement comprising two tuned stages L_0 , L_1 whose circuits 3 and 4 are tuned to the frequency ω for which maximum reaction is desired. The reaction voltage 2 is utilized in the same way as in Fig. 1 so that, in the presence of resonance, operation is the same as in this arrangement. If, however, resonance is departed from it will be seen that for very low frequencies, the voltage will lead by an angle equal to $\pi/2$ at 5 in reference to the input potential, and by the same amount in 2 in reference to potential 5; hence, reaction occurs with a total phase displacement of π so that it has the nature of an anti-regeneration or degenerative action. The same circumstance holds good for very high frequencies. The last frequency for which there exists still a little effective regeneration (total phase shift between 5 and 1 near $\pi/2$) is clearly the frequency which gives rise to a phase shift of $\pi/4$ in each of the circuits 3 and 4, that is, a frequency ω_1 such that

$$\left| \frac{\omega_1 - \omega}{\omega} \right| \approx \frac{r}{L\omega}$$

where r the resistance and L the inductance of these circuits which is a small quantity, whereas for all frequencies ω' such that

$$\left| \frac{\omega' - \omega}{\omega} \right| > \frac{r}{L\omega}$$

there exists a condition of anti-regeneration or degeneration. This will clearly demonstrate the great improvement which this invention discloses over conventional regenerative circuit organizations.

Fig. 7 shows a circuit arrangement being practically similar in all respects to Figure 6 except that recourse is had to series resonance circuits. The resistances r_1 and r_2 in the plates of the tubes are low, say, of an order of magnitude of resistance r in the inductance coils, and it is known that by means of this condition series resonance circuits are selective (see in this connection FP No. 726,536 dated Jan. 22, 1931, of Société la Radiotechnique). Once this situation has been understood it will be seen that the circuit Fig. 7 presents the same advantage as the one in Fig. 6, that is to say, that it gives rise to a very effective anti-regeneration as soon as the band passed by the constituent circuits assumed to be free from reaction is departed from.

It will be evident that there are a great number of modifications adapted to insure the identical results, though all of them must contain as a minimum number of elements the two valves or tubes together with those of two tuned circuits, and these modifications naturally fall inside the scope and spirit of this invention.

It is likewise possible, by the methods of this invention, to secure reaction in reference to more than one frequency rather than merely one.

Fig. 8 shows a circuit arrangement comprising series resonance stages, tube L_0 presenting selective amplification for frequencies ω_1 and ω_2 , one tube L_1 being provided so as to improve the gain and the selectance for frequency ω_2 while a tube L'_1 is employed for frequency ω_1 . The regeneration voltages 2 and 2' are combined by the aid of a potentiometer arrangement comprising resistors P_1 , P_2 , and R and are fed back in series with the potential I .

Fig. 9 shows an arrangement endowed with similar properties as that shown in Fig. 8, but using only a single tube L_1 for the two frequencies ω_1 and ω_2 . The means resulting in reaction are indicated in the diagram. The plate of the tube L_0 includes the two resonant circuits for the frequencies ω_1 and ω_2 . The voltage developed across these circuits is impressed upon the grid of the tube L_1 through the connection from the grid to the intermediate point of the circuit including resistors P_1 and P_2 . The plate circuit of the tube L_1 includes two series resonant circuits in parallel for the frequencies ω_1 and ω_2 . In this case the voltage developed across these two tuned circuits is brought back to the grid of tube L_0 by the tapped connection 2 to the resistor R_2 , thus providing a controllable feedback.

The arrangements Figs. 8 and 9 inhere the interesting property that they make possible selective amplification for two different frequencies, and it will be evident that this could be extended to include a greater number of dissimilar frequencies. If these valves are used as oscillators either by suppressing the impedance causing potential I on the grid or else by introducing no external voltage in the system, there results an oscillator which, at will, is capable of oscillating at frequency ω_1 or frequency ω_2 according to the regulations of certain elements, for instance, the resistances P_3 , P_4 in Fig. 9. An extremely small variation in the ratio of

$$\frac{P_3}{P_4}$$

will cause a sudden change from ω_1 to ω_2 , and vice versa.

Using the circuit organizations described as amplifiers, it is evident that they could be used without any regeneration at all, while securing selective arrangements endowed with certain desirable properties. As regards tubes L_1 and L_0 here suggested, these could also be replaced by tubes of the triode-pentode pattern, as pointed out previously in connection with the circuit organization shown in Fig. 1.

What I claim is:

In a relay circuit, a pair of cascaded electronic tubes, each of said tubes having an input circuit and an output circuit, means for feeding back energy from the output circuit of the second tube to the input circuit of the first tube com-

prising a potentiometer connected across the output circuit of the second tube and including an adjustable tap which is connected to a point of the input circuit of the first tube, each of said output circuits including a circuit which is resonant at a predetermined frequency at which maximum reaction is desired whereby the phase of the energy fed back from the output circuit of the second tube to the input circuit of the first tube reverses as the frequency thereof departs from said predetermined frequency, each of the output circuits of said tubes including a plurality of resonant circuits, the resonant circuits in any one of the output circuits being tuned to different frequencies.

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