

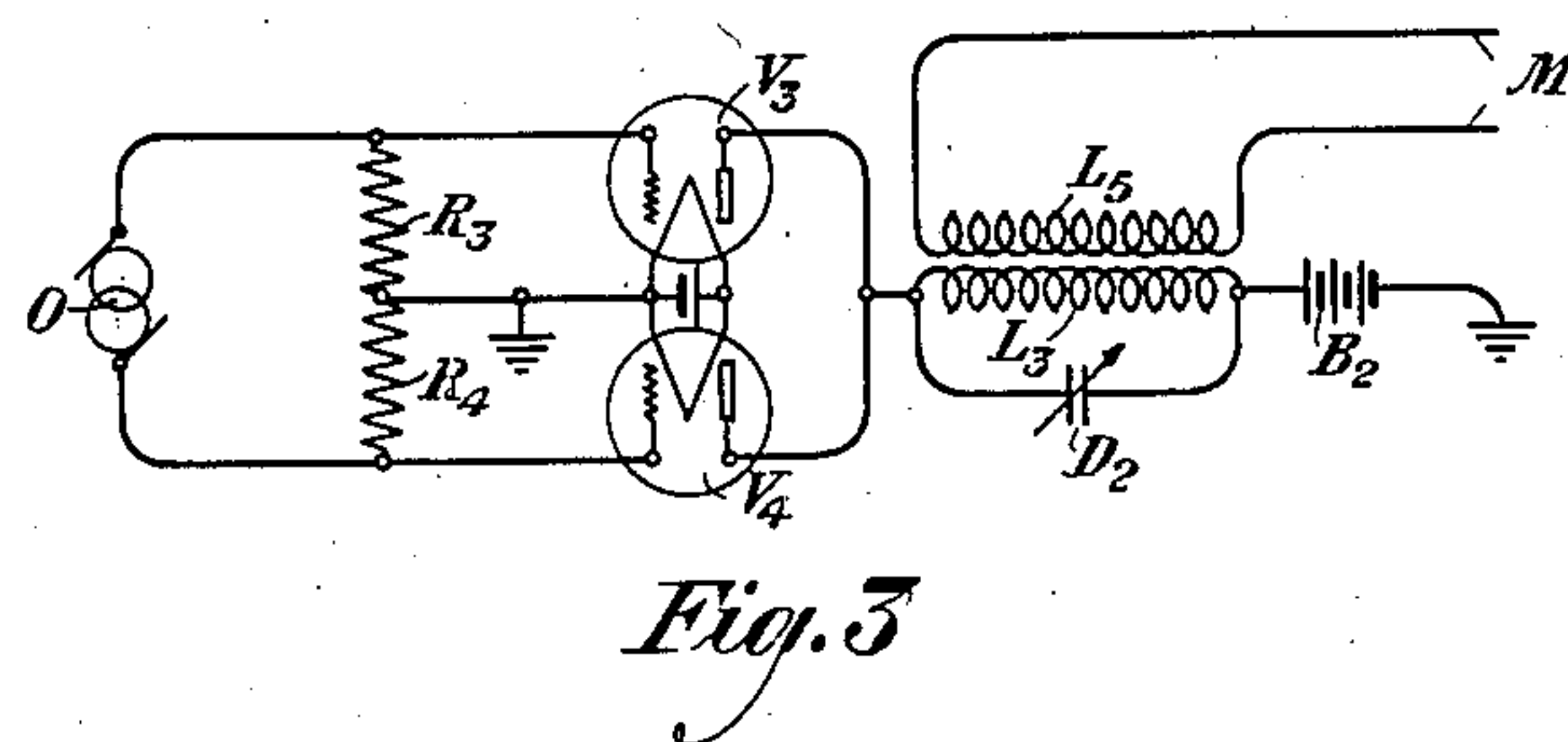
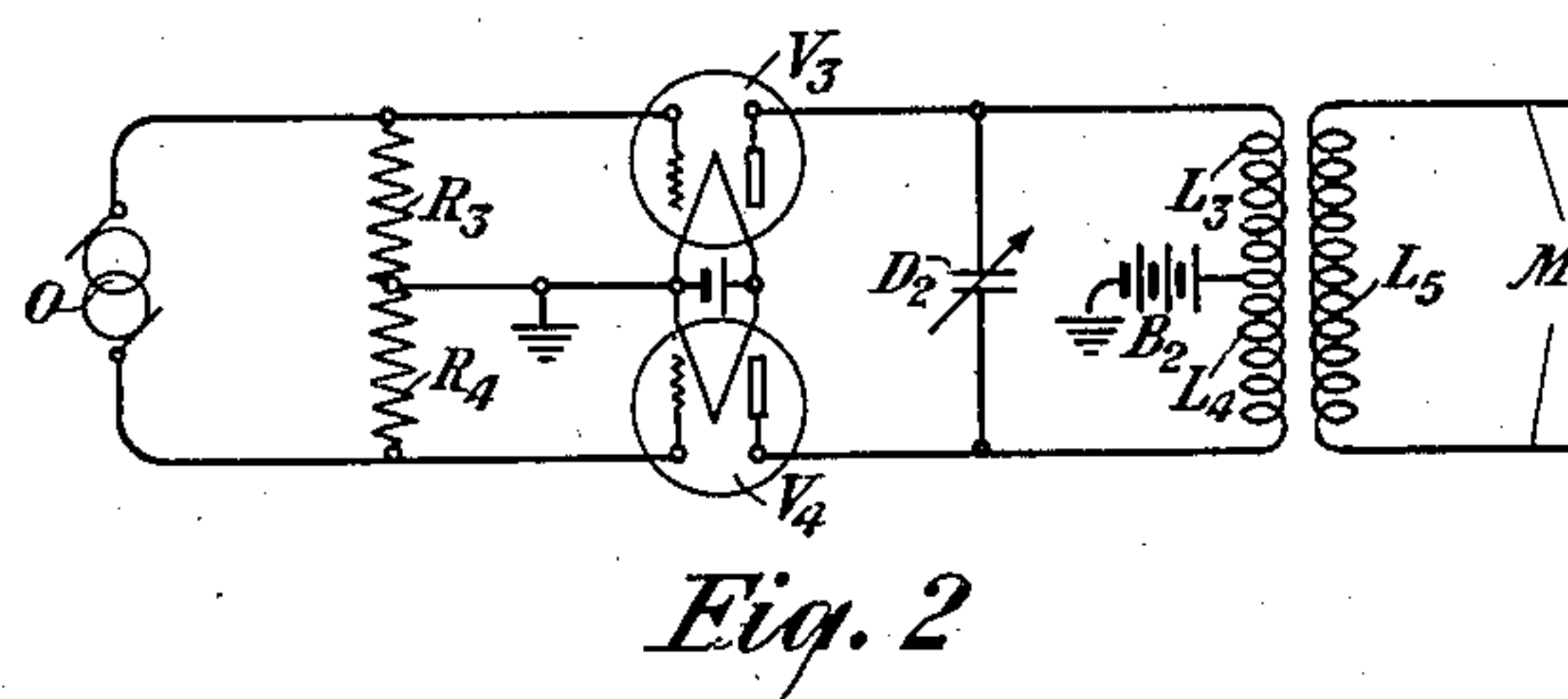
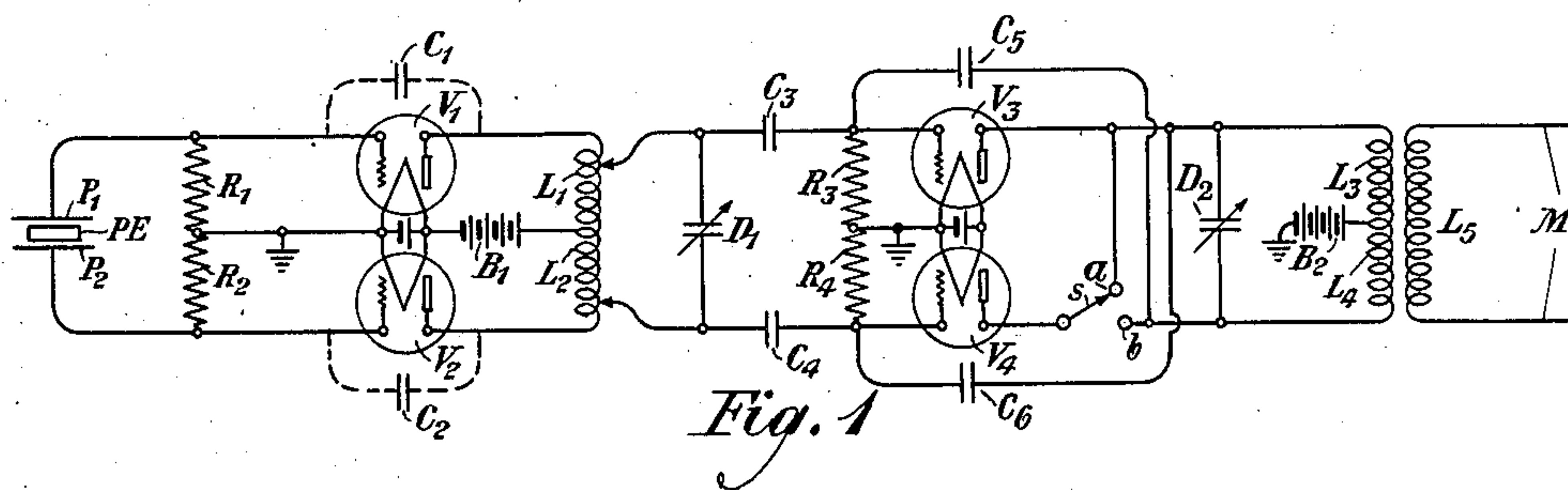
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HARMONIC PRODUCER

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HARMONIC PRODUCER

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This invention relates to harmonic producers, and particularly to arrangements for producing any desired odd or even harmonic of a fundamental frequency, to the exclusion of all other harmonics of the fundamental frequency.

In high frequency transmission systems in which an oscillator is employed, to which a piezo-electric crystal is connected to control the frequency of the oscillations sustained within very narrow limits, it is very often necessary to couple the oscillator to one or more harmonic producers to multiply the frequency of the oscillator by some integral value. Amplifiers are also coupled to the oscillator to increase the level of energy at the same time that multiplication in frequency takes place. In this invention, it is proposed to provide a system for producing either odd harmonics, such as the third, fifth and seventh harmonics, etc., or even harmonics, such as the second, fourth and sixth harmonics, etc., of some fundamental frequency, and thereafter to select and transmit any desired odd or even harmonic, to the exclusion of all other odd or even harmonics.

It is accordingly one of the objects of this invention to so relate an oscillator to a harmonic producer that either odd or even harmonics of the frequency of the oscillator will be produced by the system.

It is another object of this invention to so relate an oscillator of fundamental frequency to one or more harmonic producers, that a plurality of odd harmonics, or a plurality of even harmonics, may be produced, and to further select and transmit a desired odd or even harmonic to the exclusion of all other harmonics.

While the invention will be pointed out with particularity in the appended claim, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing, in which Figure 1 shows a push-pull oscillator, to which a piezo-electric device is connected, coupled to a push-pull harmonic producer so arranged

as to produce odd or even harmonics of the oscillator frequency, and in which Figs. 2 and 3 represent push-pull harmonic producers for producing odd harmonics and even harmonics, respectively. Similar apparatus will be designated by similar reference characters wherever they appear throughout the drawing.

Referring to Fig. 1 of the drawing, there is shown a push-pull oscillator which comprises two three-element thermionic tubes V_1 and V_2 , each having a filament, a grid and a plate, the filaments of which are heated to an electron-emitting temperature by a common battery. The tubes V_1 and V_2 are preferably similar and equal in their structure and characteristics, and may obviously be replaced by a single duplex tube having a single filament, two grids and two plates. Connected between the grids and the filaments of the three-element thermionic tubes are resistances R_1 and R_2 , respectively. Each resistance maintains the grid of the corresponding vacuum tube at a suitable negative potential with respect to the filament. A piezo-electric device is connected to the grids of the thermionic tubes V_1 and V_2 . This piezo-electric device comprises a piezo-electric crystal PE which vibrates freely between a pair of conductive electrodes P_1 and P_2 . This piezo-electric device maintains the frequency of oscillations sustained by the push-pull oscillator constant within very narrow limits. It is to be understood, however, that any means familiar to the art may be employed to vary the vibratory period of the piezo-electric device in order to effect a corresponding variation in the frequency of the oscillations sustained by the push-pull oscillator. A battery B_1 supplies the necessary space potential for the plates of the vacuum tubes V_1 and V_2 through inductances L_1 and L_2 , respectively. A variable condenser D_1 bridges inductances L_1 and L_2 , thereby providing a local circuit which has no reactance, or substantially negligible reactance, at the frequency characteristic of the push-pull oscillator. The plate and grid circuits of the vacuum tubes V_1 and V_2 are coupled by virtue of the inherent capacities

C_1 and C_2 (shown in dotted lines), respectively, existing between the plate and grid electrodes of these vacuum tubes.

The oscillations of the oscillator, controlled as to frequency by means of the piezo-electric device, are transmitted to the harmonic producer. This harmonic producer is shown to comprise another duplex system having two three-element thermionic tubes V_3 and V_4 , each also having a filament, a grid and a plate, the filaments of which are also heated to an electron-emitting temperature by a common battery. These tubes may also be similar and equal in their structure and characteristics, and may also be replaced by a single duplex tube having a single filament, two grids and two plates. The grid and filament of the vacuum tube V_3 are connected to a resistance R_3 , and the grid and filament of the tube V_4 are connected to a resistance R_4 . Oscillations sustained by the oscillator are transmitted to the grids of the vacuum tubes V_3 and V_4 through condensers C_3 and C_4 , respectively. The condenser C_3 and the resistance R_3 , and the condenser C_4 and the resistance R_4 provide the proper time constants for the input circuits of the vacuum tubes V_3 and V_4 , respectively. Condensers C_5 and C_6 are employed to prevent the transmission of the first harmonic or fundamental frequency to the output circuits. A battery B_2 supplies the necessary space potential for the plates of the vacuum tubes V_3 and V_4 .

When a switch S is thrown so as to close contact a , the plates of the vacuum tubes V_3 and V_4 are effectively in parallel relationship with each other, and the potential of the battery B_2 is supplied to these plates through an inductance L_3 . Yet, when the switch S is thrown so as to close contact b , the output circuits of the vacuum tubes V_3 and V_4 are effectively in push-pull relationship with each other, and the potential of the battery B_2 is supplied to the plates of the vacuum tubes V_3 and V_4 through inductances L_3 and L_4 , respectively. Under certain conditions, the winding L_4 may be so arranged as to assist winding L_3 in building up oscillations, and, under other conditions, the winding L_4 may be so arranged as to buck winding L_3 . The inductances L_3 and L_4 are coupled to an inductance L_5 , the inductance L_5 being connected to the leads or conductors M of an output circuit.

When the switch S closes contact a , the plates of the vacuum tubes V_3 and V_4 are in parallel relationship with each other. Even harmonics of the fundamental frequency are produced, the odd harmonics and the fundamental frequency being neutralized and rendered otherwise substantially ineffective by virtue of their presence in two conditions which are in phase opposition. A variable condenser D_2 may then be manipu-

lated to co-operate with the inductances L_3 and L_4 so as to provide a locally tuned circuit which has substantially no reactance at any one of the even harmonics. The selected even harmonic will then be transmitted to the inductance L_5 and to the output circuit connected to the leads or conductors M , to the exclusion of all other even harmonics.

When the switch S closes contact b , the output circuits of the vacuum tubes V_3 and V_4 are then effectively in push-pull arrangement, and consequently a plurality of odd harmonics will be produced by manipulating the variable condenser D_2 . Any one of the odd harmonics may be selected and transmitted to the tuned circuit connected to the leads or conductors M , to the exclusion of all other odd harmonics. Moreover, when the switch S is so connected, the even harmonics and the fundamental frequency are neutralized and rendered otherwise ineffective by virtue of their presence in the output circuits of the vacuum tubes V_3 and V_4 in opposite phases.

It will be understood that if the piezo-electric device of this invention were so arranged that its vibratory period could be varied as found desirable, the frequency of the oscillator to which it is connected would be similarly varied, as would also the frequency of the harmonic produced by the harmonic producer. The piezo-electric device would, at the same time, maintain the oscillations of that harmonic constant in frequency within very narrow limits.

Fig. 2 shows an oscillator O connected to a similar harmonic producer of the duplex type shown in Fig. 1 for producing odd harmonics of the frequency of the oscillator, and, more particularly, any desired odd harmonic, to the exclusion of all other odd harmonics. The circuit of the harmonic producer of Fig. 2 corresponds to the circuit of the harmonic producer of Fig. 1 when the switch S closes contact b . It will be fairly obvious that a plurality of odd harmonics are produced by this arrangement, and that any one of these harmonics may be selected by manipulation of the variable condenser D_2 and transmitted to the output circuit connected to the leads or conductors M , to the exclusion of all other odd harmonics.

Fig. 3 shows a harmonic producer for producing an even harmonic of the fundamental frequency of an oscillator O . In this arrangement, the plates of the vacuum tubes V_3 and V_4 are in parallel relationship with each other, and are supplied with the proper plate potential by a battery B_2 through an inductance L_3 . Any one of the even harmonics may be selected by manipulation of the variable condenser D_2 . The selected even harmonic is transmitted to the

inductance L_s and then to the output circuit connected to the leads M.

While this invention has been shown in certain particular embodiments, merely for the purpose of illustration, nevertheless the principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claim.

What is claimed is:

10 The combination of two three-element vacuum tubes, a resistance interconnecting the grid electrodes of said vacuum tubes, a source of alternating current of fundamental frequency coupled to said resistance, 15 a winding, means to connect the plate electrodes of said vacuum tubes in parallel relationship with each other and in series relationship with said winding whenever even harmonics are desired, means to connect the 20 plate electrodes of said vacuum tubes in series relationship with each other and with said winding whenever odd harmonics are desired, means for rendering said winding 25 selective to any predetermined odd or even harmonic, and a piezo-electric device coupled to said source to maintain its frequency constant as well as the harmonic selected by said winding.

30 In testimony whereof, I have signed my name to this specification this 28th day of October, 1926.

RUSSELL S. OHL

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