Aug. 15, 1950 R. B. DOME 2,519,029

SELECTIVE SYSTEM

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Fig. 1.

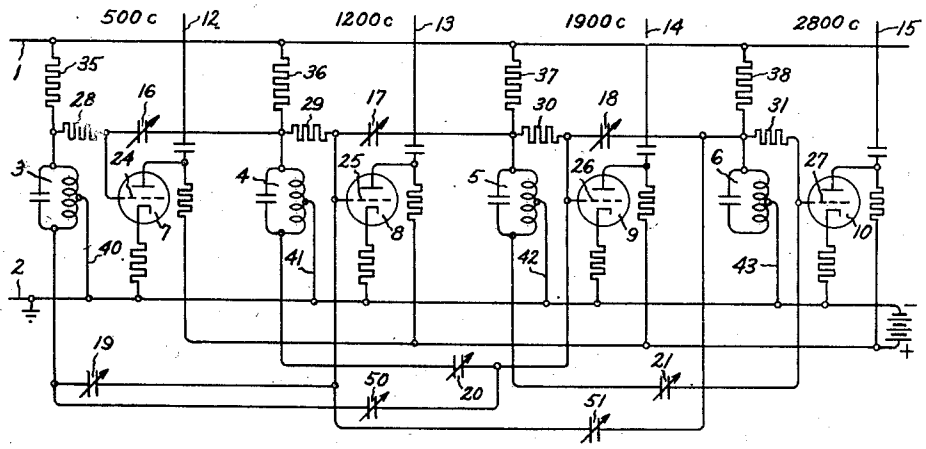


Fig. 2.

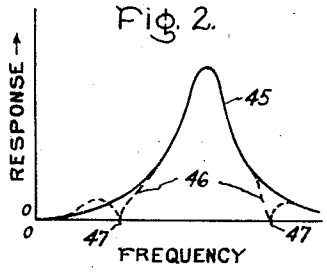


Fig. 3.

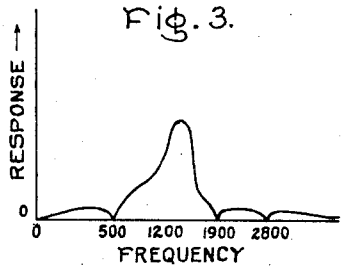
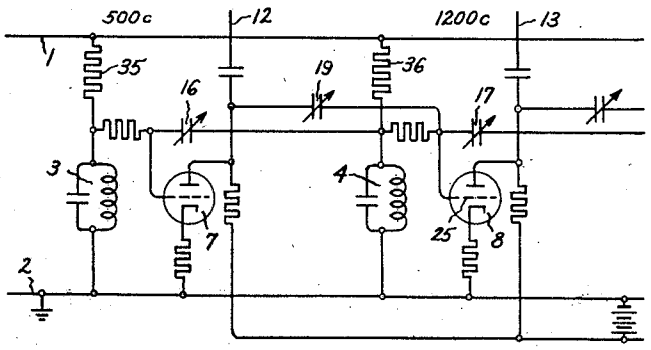


Fig. 4.



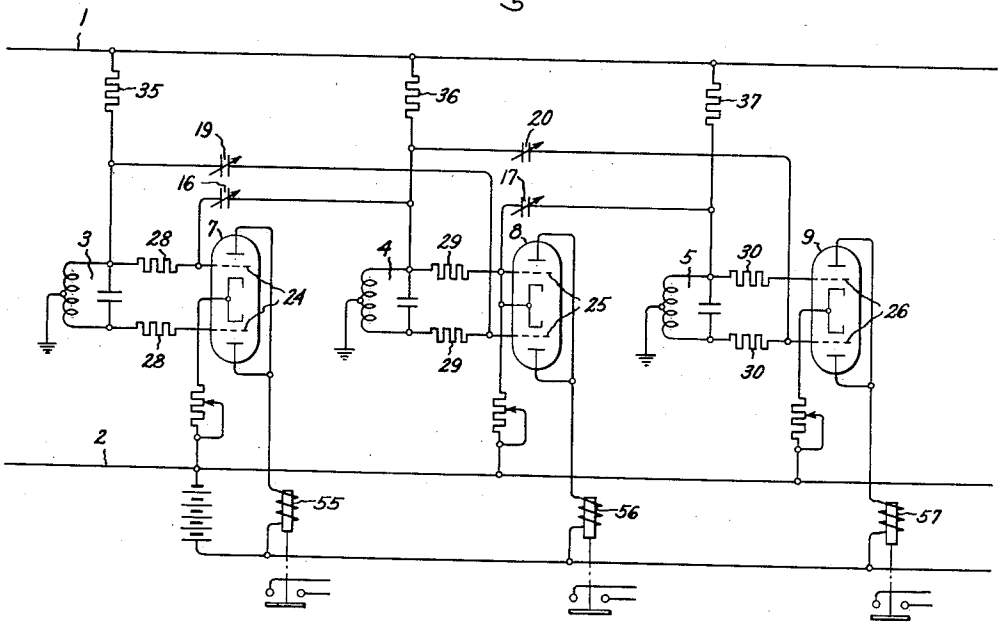
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SELECTIVE SYSTEM

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Fig. 5.



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SELECTIVE SYSTEM

Robert B. Dome, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

Application September 7, 1945, Serial No. 615,030

5 Claims. (Cl. 178—44)

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My invention relates to selective systems and more particularly to systems for selecting into individual channels oscillations of different frequencies which may exist in a single channel.

An object of my invention is to provide certain improvements in such selecting means.

Another object of my invention is to provide an improved selecting system having increased assurance against transmission in any channel of oscillations having an adjacent channel frequency.

Still another object of my invention is to provide neutralizing means to reduce transmission in any channel of oscillations having adjacent channel frequencies.

A further object of my invention is to provide such neutralizing means capable of substantially reducing transmission in any channel of oscillations having the frequencies transmitted by any of the other channels and which may be provided with a minimum of complication of the circuits employed.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention; Figs. 2 and 3 represent certain characteristics pertaining to its operation; Figs. 4 and 5 represent modifications thereof.

Referring to Fig. 1 of the drawing, I have indicated at 1 and 2 the conductors of an input channel between which may be impressed oscillations of different frequencies, which are to be selected from each other and transmitted through individual channels corresponding to the different frequencies. These individual channels include tuned circuits 3, 4, 5 and 6, respectively, from each of which oscillations may be supplied through corresponding electron discharge devices 7, 8, 9 and 10 to corresponding output circuits represented by conductors 12, 13, 14 and 15. These output circuits may include any desired devices to be operated in response to oscillations of the selected frequency.

It is desired that oscillations of a single frequency be supplied to each of the circuits represented by conductors 12, 13, 14, and 15 and that means be provided in each channel to prevent flow therein of oscillations of frequency corresponding to any of the other channels.

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Of course, the greater part of this frequency selection is effected by the tuned circuits 3, 4, 5, and 6 individual to the different channels. It has been found, however, in the operation of systems of the type described that oscillations of undesired frequency corresponding to the frequency of a channel adjacent in frequency appears on these different tuned circuits and that the intensity of such oscillations may be a considerable part of the magnitude of the oscillations of desired frequency. If circuits 3, 4, 5 and 6 be tuned, for example, to 500, 1200, 1900 and 2800 cycles, respectively, the intensity of oscillations of an adjacent undesired frequency appearing on any tuned circuit may be 15 per cent, or even greater, of the magnitude of oscillations of desired frequency.

To prevent these oscillations of undesired frequency from being transmitted through the respective discharge device with objectionable magnitude, means are provided to neutralize such oscillations. This means comprises condensers 16, 17 and 18 and 19, 20 and 21. The condensers 16, 17 and 18 are each connected between the control electrode 24, 25 and 26 of a corresponding discharge device and one terminal of the tuned circuit 4, 5 or 6 tuned to the next higher frequency. In addition, resistances 28, 29, 30 and 31 are connected between each tuned circuit and the control electrode of the respective discharge device. Each of these resistances and the associated condenser operates as a phase shift network to supply to the respective channel oscillations of the undesired frequency from a channel tuned to such undesired frequency in phase to neutralize the undesired oscillations appearing in the respective channel.

Condensers 19, 20 and 21 are likewise connected between the grid of the corresponding discharge device and the opposite terminal of a tuned circuit 3, 4 or 5 tuned to the next adjacent lower frequency. These condensers operate in the same way to effect neutralization of undesired oscillations in any channel lower than the channel frequency of the respective channel.

For a more detailed consideration of the operation of the system, assume that circuit 4 is tuned to 1200 cycles. Oscillations of that frequency appear thereon with large intensity. If circuit 5 be tuned to 1900 cycles, that frequency also appears on circuit 4 and may appear with objectionable intensity. Since these 1900 cycle oscillations are of higher frequency than the frequency to which the circuit 4 is tuned, this circuit 4 appears as a capacity in series with resistance 36 across the channel 1, 2 and accord-

ingly the voltage on circuit 4 lags in phase the voltage on the circuit 1, 2 by nearly ninety degrees. Of course, all of the voltage on circuit 4 is supplied through resistance 29 to the grid 25. Oscillations of this undesired frequency appear with large intensity on circuit 5 and since that circuit is tuned to this frequency, these oscillations are in phase with the oscillations of the same frequency on the input circuit 1, 2. These oscillations are supplied from circuit 5 through condenser 17 to the grid 25 of discharge device 8 in opposite phase to the undesired oscillations supplied thereto from circuit 4. Since oscillations of this undesired frequency appear in circuit 5 with far greater intensity, in one instance six times greater intensity than the undesired oscillations in circuit 4, condenser 17 may be of small capacitance or high reactance relative to the resistance of resistor 29 and thus it operates to shift the phase of these oscillations by nearly ninety degrees to substantially exact opposition with the undesired oscillations from circuit 4 between the grid and cathode of device 8.

Of course, oscillations of the next lower frequency, 500 cycles, also appear in circuit 4. That circuit acts as an inductance to these oscillations, this inductance being in series with resistance 36. Oscillations of the 500 cycle frequency appear thereon leading in phase the voltage on circuit 1, 2 by nearly ninety degrees.

To neutralize these oscillations, as they appear on grid 25, condenser 19 is connected between grid 25 and the lower terminal of circuit 3 tuned to these lower frequency oscillations. It will be observed that each of the tuned circuits 3, 4, 5 and 6 have the intermediate points thereof connected through respective conductors 40, 41, 42, 43, respectively, to ground conductor 2 of the system so that the oscillations of the lower terminals of these circuits are opposite in phase to the oscillations at the upper terminals thereof. Condenser 19 is then proportioned to supply these oscillations to the grid 25 leading in phase the oscillations at the lower terminal of circuit 3. Since the oscillations at the lower terminal of circuit 3 are opposite in phase to the oscillations on circuit 1, 2 these oscillations are supplied to grid 25 in exact opposition to oscillations of the same frequency supplied from circuit 4 to grid 25.

In this same way, each of the different channels may be neutralized with respect to the frequency of the channel adjacent in frequency.

Since the channel 3, 7, 12 operates at the lowest frequency, neutralization for lower frequencies is not required. Hence condenser 16 is employed to effect neutralization at the next higher frequency.

Condensers 18 and 20 effect neutralization at the grid of discharge device 9 at the respective higher and lower frequencies of channel 5.

Since, as illustrated, discharge device 10 operates at the highest frequency of the system, it is only necessary to neutralize at the lower frequency. Hence only condenser 21 is employed.

Of course, the system may be extended to include as many frequencies as desired.

In Fig. 2 I have shown the frequency-response characteristic of one of the channels, for example, channel 4, 8, 13, of Fig. 1, the response at the output of the channel being plotted as ordinate against frequency as abscissa. The full line 45 shows the response when no neutralization is employed and the dotted line curve 46 shows the response when the system is provided with condensers 17 and 19 for neutralization at the adjacent channel frequencies. The peak of the curve 45, of course, indicates the response at the channel frequency and the minima 47 of the curve 46 indicate the response at the adjacent channel frequencies.

It may be necessary in certain situations to effect neutralization not only for the adjacent channel frequencies but for frequencies more removed. This may be effected by means of condensers connected as indicated at 50 and 51, for example. Thus, undesired oscillations may appear in circuit 4 not only at 500 and 1900 cycle frequencies but also at the 2800 cycle frequency. To effect neutralization at the 2800 cycle frequency, the condenser 51 may be connected between the upper terminal of the circuit 6, tuned to that frequency, and the grid 25 of the discharge device 8. Similarly, in circuit 5, undesired oscillations may appear of not only the 1200 and 2800 cycle frequencies but also of the 500 cycle frequency. The 500 cycle frequency oscillations may be neutralized on grid 26 by use of condenser 50 connected between the lower terminal of circuit 3 and the grid 26. In the four-channel system illustrated in Fig. 1, only four such condensers are needed to effect neutralization at these more removed channels but, if additional channels were employed, additional condensers would be similarly connected.

Fig. 3 represents the frequency-response characteristic for the 1200 cycle channel when neutralized for frequencies of the nearest three adjacent frequencies. It will be observed that the response indicated by the curve is at minimum at the 500, 1900 and 2800 cycle frequencies.

Usually neutralization for more remote frequencies, where such frequencies are employed, is not required, although it may be effected if desired by additional condensers appropriately connected to the respective circuits.

Fig. 4 shows that portion of the system of Fig. 1 comprising the 500 and 1200 cycle channels. The system differs from Fig. 1 only in that the circuits 3 and 4 have their lower terminals connected to ground rather than having an intermediate point connected to ground as in Fig. 1. This means that a different measure must be obtained to secure oscillations of the proper phase to effect neutralization in any channel of oscillations of the next adjacent lower frequency. For example, in Fig. 1, to effect neutralization in the 1200 cycle channel of oscillations of the 500 cycle frequency, condenser 19 was connected between the grid 25 and the lower terminal of tuned circuit 3. In Fig. 4 this condenser is connected between the grid 25 and the anode of the discharge device 7 in the 500 cycle channel where oscillations of the desired phase are available. Of course, this character of change may be effected throughout the system, if additional channels are employed. In other respects the system is similar to that of Fig. 1.

Fig. 5 represents a further modification of my invention in which relays 55, 56 and 57 are connected in the individual channels to be operated in response to oscillations of the frequency transmitted by the respective channels. The discharge devices 7, 8 and 9 each comprise two triodes in the same envelope, their cathodes being connected to the conductor 2 and their anodes being connected together and through the respective relays to the source of operating potential and thence to conductor 2. The control electrodes of each of these discharge devices are connected in push-pull relation to opposite terminals of the

respective tuned circuit 3, 4, 5 through respective resistances 28, 29, 30. The upper terminal of each of these tuned circuits is also connected through resistances 35, 36 and 37, respectively, to the conductor 1.

In one system having the circuit structure illustrated in this Fig. 5 and in which the tuned circuits 3, 4 and 5 were tuned, respectively, to 300, 420, and 590 cycles, these resistances 28, 29, 30 were 150,000 ohms each and the resistances 35, 36, 37 were 24,000 ohms each. Neutralization on the grids 24 of discharge device 7 for the 420 cycle frequencies is effected by condenser 18 connected between the upper grid 24 and the upper terminal of the tuned circuit 4. By reason of the balanced action of circuit 3 this also effects neutralization at the lower grid 24 of discharge device 7. In this connection the neutralizing voltage at the upper grid 24 must be doubled to offset the unneutralized voltage on the lower grid 24. Balancing will then occur in the common anode currents set up through relay coil 55.

To effect neutralization at the 590 cycle frequency at the grids 25 of discharge device 8, the condenser 17 is employed. Similarly, to effect neutralization at these grids of the 300 cycle frequency, the condenser 19 is employed connected between the lower grid 25 and the upper terminal of circuit 3. To effect neutralization at the grids 26 of discharge device 9 for the 420 cycle frequency, condenser 20 is employed connected between the lower grid 26 and the upper terminal of circuit 4.

A resistance, which may be 2000 ohms, is connected between the cathode of each of these discharge devices and ground and these discharge devices operate as detectors to cause operation of the different relays 55, 56 and 57 in response to the respective frequencies.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination, in a multi-channel system, a channel on which may appear oscillations of a plurality of frequencies, a plurality of parallel-resonant circuits connected across said channel each tuned to a corresponding one of said frequencies, each tuned circuit having a decoupling resistance in series therewith, whereby oscillations of the frequency to which any tuned circuit is tuned appear thereon with large intensity and oscillations of another of said frequencies appear thereon with less intensity and in phase displaced from the phase of oscillations of the same frequency on said channel, an output electron discharge device having a grid circuit energized from each tuned circuit and arranged to respond to said oscillations of large intensity, each of said grid circuits including a series resistance, and means to prevent response of said output device to said oscillations of less intensity, said last means including reactive means to supply to the input of said output device oscillations of the frequency of said oscillations of less intensity from that other one of said circuits tuned to said frequency, said reactive means and said series resistance together forming a phase-shifting network arranged to supply oscillations from said other circuit in phase to oppose said oscillations of less intensity.

2. The combination in a selective system, of an input channel on which oscillations of different frequencies to be selected appear, a plurality of electron discharge devices, each having an anode, a cathode, and a control electrode, said cathode being connected to one side of said channel and said control electrodes being connected to the other side of said channel through a resistance, a tuned circuit for each discharge device, each tuned circuit being resonant to a corresponding frequency and connected between said cathodes and an intermediate point on said resistance, and a condenser connected between the control electrode of one of said devices and a tuned circuit resonant at another of said frequencies, said condenser having such value that oscillations of said other frequency supplied therethrough substantially neutralize oscillations of the same frequency supplied through said resistance.

3. In combination, a channel on which may be impressed oscillations of three or more frequencies, at least three load circuits connected across said channel each having a circuit tuned to a respective one of said frequencies, whereby oscillations of the intermediate one of said frequencies appear on the corresponding tuned circuit with high intensity and oscillations of higher and lower frequencies appear thereon with lower intensities, a load electron discharge device connected to said corresponding tuned circuit through a resistance, and means to supply oscillations from one of said circuits tuned to a higher frequency to said load device to neutralize oscillations of the same frequency supplied thereto through said resistance, and means to supply oscillations from one of said tuned circuits tuned to a lower frequency to said device to substantially neutralize oscillations of said lower frequency supplied thereto through said resistance.

4. In combination, a channel on which may appear oscillations of three or more frequencies, at least three electron discharge devices, each having a cathode connected to one side of said channel and a control electrode connected to the other side of said channel, at least three tuned circuits each tuned to a corresponding one of said frequencies, each tuned circuit having an intermediate point connected to said cathodes and one terminal connected to the control electrode of a corresponding one of said discharge devices, whereby each discharge device may respond to the voltage on the respective tuned circuit to which said respective tuned circuit is resonant, and means to prevent a discharge device responsive to an intermediate one of said frequencies from responding to voltage on the respective tuned circuit of frequency higher or lower than the frequency to which the respective discharge device responds, said means comprising a condenser connected between the control electrode of said last discharge device and one terminal of the tuned circuit tuned to a lower frequency and a second condenser connected between said control electrode and the opposite terminal of the tuned circuit tuned to a higher frequency.

5. In combination, a channel on which may appear any of at least three frequencies, a plurality of additional channels connected thereto, each responsive to a corresponding one of said

frequencies, and each including a tuned circuit having a midpoint connected to one side of said first channel and one terminal connected to the other side of said first channel through a resistance, a plurality of load electron discharge devices, each having a push-pull input circuit connected across a corresponding one of said tuned circuits, a condenser connected between one side of the input circuit of the load device connected to a circuit tuned to an intermediate one of said frequencies and one terminal of a circuit tuned to a higher frequency, and a second condenser connected between the opposite terminal of said input circuit and a point on a circuit tuned to a lower frequency.

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