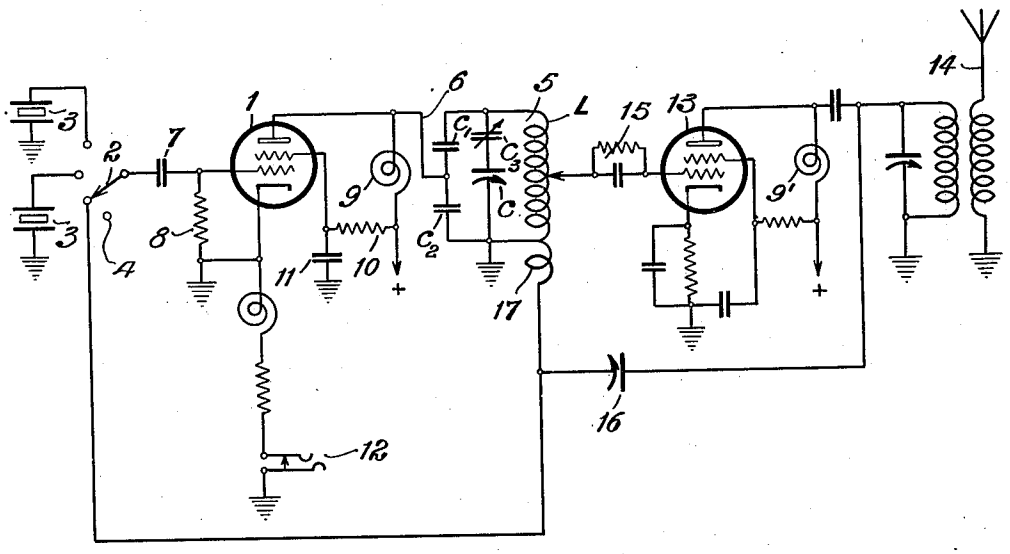
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RADIO TRANSMITTER

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RADIO TRANSMITTER

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This invention relates to radio transmitter circuits, particularly to such circuits for use by radio amateurs.

In operating an amateur transmitter, it is desirable to have available a piezo-electric crystal as the frequency determining element for providing a fixed frequency, and also a "circuit control" for enabling the transmitter to operate on a frequency which is different from the frequency of the crystal. The crystal is desirable in the transmitter as a standard fixed frequency. Operators of other stations, such as friends, learn to recognize this frequency. Such a fixed frequency is more stable under varying conditions than conventional tuned circuits, and is a frequency which is reproducible without careful setting of the tuning and which cannot be altered easily by mistake, as by brushing against the dial. The "circuit control" mentioned above has the advantage of enabling the transmitter to shift frequency to any desired value. Such a shift in frequency from the fixed frequency provided by the crystal is usually done to avoid interference from other stations, and also enables a group of geographically spaced amateurs to operate their respective transmitters on the same frequency so as to avoid retuning when all are engaged in a round table conference, which retuning would be necessary if different transmitter frequencies were employed at the different amateur stations. Another advantage of the "circuit control" is that it enables the operator to break into a radio communication circuit by adjusting the frequency of the transmitter to interfere with the communication circuit, thus calling attention to the fact that the breaking in operator desires contact.

Transmitters are often provided with both types of control, but too often one is not fully satisfactory, in which case the operator tends to use the other exclusively. In accordance with the present invention, a transmitter is provided which permits extremely simple switching between the two above mentioned types of control (that is, between the crystal control and the "circuit control") with as satisfactory a degree of operation with either type of control as though the transmitter were designed solely for only one type of control.

Briefly stated, the gist of the invention lies in the use of a transmitter having an oscillator provided both with a crystal control circuit and also with a self or circuit control arrangement, in which the oscillator can be changed between these two types of control without any appreciable change in the strength of oscillations produced. The transmitter is so designed that in the self or "circuit control" position the tuned oscillatory circuit is loosely coupled to the vacuum tube electrodes of the oscillator for stability of operation, while in the crystal position, the same loose coupling of the tuned circuit to the anode of the oscillator results in relatively low voltage across the crystal.

A feature of the invention lies in the use of a simplified switching scheme by means of which there may be selected any one of a number of crystals without undue complication of the switching arrangement.

A more complete description follows in conjunction with a drawing, whose single figure schematically illustrates a transmitter constructed in accordance with the principles of the present invention.

Referring to the drawing, there is shown an oscillation generation system comprising a screen grid vacuum tube 1 whose grid is coupled to a switch 2 for connecting the grid either to any one of a plurality of piezo-electric crystals 3, 3 or to a circuit control contact 4, the latter being connected to the tuned oscillatory circuit (tank) 5. The anode of the oscillator 1 is connected to the tank circuit 5 by means of a connection 6 which is joined to the junction point of two series arranged condensers C_1, C_2 constituting a fixed capacity potentiometer. The tank circuit 5 includes, in addition to the condensers C_1, C_2, a condenser C in shunt to the first two condensers and in shunt to an inductance coil L. It should be noted that the anode of vacuum tube 1 is not connected to the top of the anode tuned circuit 5, but rather to a tap on the fixed capacity potentiometer C_1, C_2. In the grid circuit of the oscillator, there is provided the usual blocking condenser 7 and grid leak resistor 8, while in the anode circuit there is provided a choke coil 9 which is located between the anode and the positive terminal of a source of potential labeled +300 volts. The auxiliary coil 17 may be termed a grid coil, and serves to couple the anode tuned circuit 5 to the contact 4 for connection to the switch 2 when it is desired to operate the transmitter on "circuit control" position. The screen grid of vacuum tube 1 is connected to the positive terminal of the same source of potential through a suitable resistor 10, and is also bypassed to ground through a radio frequency bypass condenser 11.

A jack 12 may be provided between the cathode and ground for use with an external plug (not

shown) in case it is desired to key the transmitter with telegraph signals. Following the oscillator and coupled to the anode tuned circuit 5 is a screen grid amplifier stage 13, whose output in turn is coupled to a suitable antenna 14. The grid of the power amplifier 13 is coupled through a grid condenser and leak circuit 15 to a tapping point intermediate the ends of the inductance L. In case amplifier 13 should require neutralization, there is provided a variable neutralizing condenser 16 which is coupled between a point on the anode tuned circuit of the amplifier 13 and the lower terminal of the auxiliary coil 17, thus avoiding the necessity for providing an extra winding for obtaining the required phase of voltage for neutralization of the amplifier 13.

Turning again to the tuned oscillatory circuit 5 of the oscillator, condensers C_1, C_2 are so chosen that their effective capacity in series establishes the desired band spread for the tuning condenser C. If desired, there may be provided an additional tuning condenser C_3 in series with a condenser C, so that when this additional condenser is used the effective capacity of the three condensers C_1, C_2 and C_3 establishes the desired band spread for C. The ratio of the values of condenser C_2 to C_1 is made as large as possible, while still providing sufficient inductive reactance in the anode circuit to cause the selected crystal 3 to oscillate with at least the required strength when the condenser C is properly adjusted. Putting it in other words, the maximum value of the inductive reactance is not much greater than the minimum value of anode circuit reactance required to produce crystal oscillations. These two requirements are sufficient to determine the individual values of condensers C_1 and C_2. The ratio of condensers C_2 to C_1, however, should not be so large (even if the crystal operates strongly enough) that a large number of turns are required at the grid coil 17 to obtain the desired oscillation strength. By making C_2 large, there is obtained a low impedance connection point to the tank circuit.

Although no exact figures can be given which are applicable to all kinds of vacuum tubes which can be used in a transmitter, it is sufficient to state that the capacities C_1 and C_2 and the grid coil 17 should usually be so related that the alternating voltage at the point on the anode tank circuit 5 to which the anode is connected should be several times as large as the alternating voltage picked up by grid coil 17. This is for the reason that there is usually a greater variability of effective grid capacity than of effective plate capacity in the tube, and the effect of such variability on generated frequency is proportional to the alternating voltages on these electrodes. When so constructed, the circuit is substantially as stable as the variations of circuit elements outside the tube oscillator will permit and also enjoys a high degree of freedom from parasitic oscillations. Because the anode and grid circuits of oscillator 1 have opposite reactance signs at all undesired frequencies, which is obtained by virtue of the capacity coupling scheme to the anode circuit and the inductance coupling scheme to the grid circuit, parasitics are prevented. At parasitic frequencies, the anode circuit has capacity reactance.

In constructing the transmitter of the invention, the constants of the anode circuit should first be properly determined both with reference to the proper operation of the transmitter as a crystal oscillator, and also with reference to the proper frequency range of tuning. After this has been done, the grid coil 17 is wound on, a turn at a time, until the oscillations as a "circuit control" oscillator have the desired strength; that is, about the same strength as with crystal control. Switching by means of element 2 may now be accomplished without any other adjustment than to set condenser C to its proper value. That is, if it is desired to employ crystal operation, the switch 2 is placed on the contact to which the crystal is connected, and condenser C is set to approximately the previously determined best value for the particular crystal which is used. If "circuit control" operation is desired, switch 2 is arranged to make contact with terminal 4 and condenser C now set to give a desired frequency of operation by reference to a previously determined calibration curve, or the like. The oscillator circuit of the invention provides high stability, the tank circuit 5 being non-parasitic in character and loosely coupled to the oscillator tube for a given amount of volt-amperes in the tank circuit. Since in most vacuum tubes the anode capacity is more stable than the grid capacity, it is desirable to couple the anode more closely to the tuned circuit 5 than the grid, and it is for this reason that it is preferred that there be employed a minimum number of turns in the grid coil 17 to obtain the desired oscillation strength.

If it is desired to employ speech waves in communicating by means of a transmitter circuit of the invention, modulating potentials may be applied to the anode lead of amplifier 13 which extends from the choke coil 9' to the source of anode polarizing potential.

What is claimed is:

1. In a transmitter, an oscillator comprising a vacuum tube having anode, grid and cathode electrodes, an anode-cathode circuit, a tuned oscillatory circuit coupled to said anode-cathode circuit, a coil coupled to said tuned circuit, a crystal, means for alternatively connecting said grid either to said coil or to said crystal, the coupling between said anode-cathode circuit and said tuned circuit being such as to introduce in said anode-cathode circuit an inductive reactance which, at the adjustment of said tuned circuit that yields a maximum value of said reactance, is not greatly in excess of the minimum value of anode circuit inductive reactance required to produce crystal oscillations, said coil being coupled to said tuned circuit with mutual inductance so chosen as to produce self-controlled oscillations of substantially the same strength as the crystal oscillations.

2. In a transmitter, an oscillation generator comprising a vacuum tube having anode, cathode and grid electrodes, a tuned oscillatory circuit comprising an inductance coil having in shunt thereto a variable condenser and also a capacity potentiometer, a connection from said anode to a point on said capacity potentiometer intermediate the ends thereof, means for supplying said grid with a suitable bias relative to said cathode, a switch connected to said grid, separate contacts for individual engagement with said switch, a piezo-electric crystal connected to one of said contacts, and a coil inductively coupled to the inductance coil of said tuned circuit connected to another of said contacts.

3. In a transmitter, an oscillation generator comprising a vacuum tube having anode, cathode and grid electrodes, a tuned oscillatory cir-

cuit loosely coupled to the electrodes of said tube and being composed of an inductance coil having in shunt thereto a variable condenser and also a pair of series arranged condensers, a connection from said anode to said tuned oscillatory circuit, a crystal, a coil closely inductively coupled to said inductance coil of said tuned circuit and having a relatively small number of turns, means for alternatively connecting said grid either to said crystal or to said coil of small number of turns to produce crystal controlled or self-controlled oscillations, respectively, whereby the strength of oscillation in either of the last two conditions is substantially the same, an amplifier coupled to said tuned circuit, an antenna coupled to the output of said amplifier, and a neutralizing capacity connected between a point in said amplifier output and a point on said coil of small number of turns.

4. An oscillator circuit adapted to be switched between crystal control and self-excitation without substantial change of amplitude or frequency of oscillation, comprising a tuned tank circuit, a tube including input and output electrodes, means coupling said output electrodes to a low impedance in said tank circuit, said means being such as to cause the impedance connected to said output electrodes to be capacitive at all frequencies above the said frequency of oscillation, a crystal, a coil, a switch having two points, the moving arm being connected to one of said input electrodes, one point being connected to said crystal and the other to said coil, said coil being coupled to said tank with initial inductance so adjusted as to equalize the strength of oscillations in the two switch positions.

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