

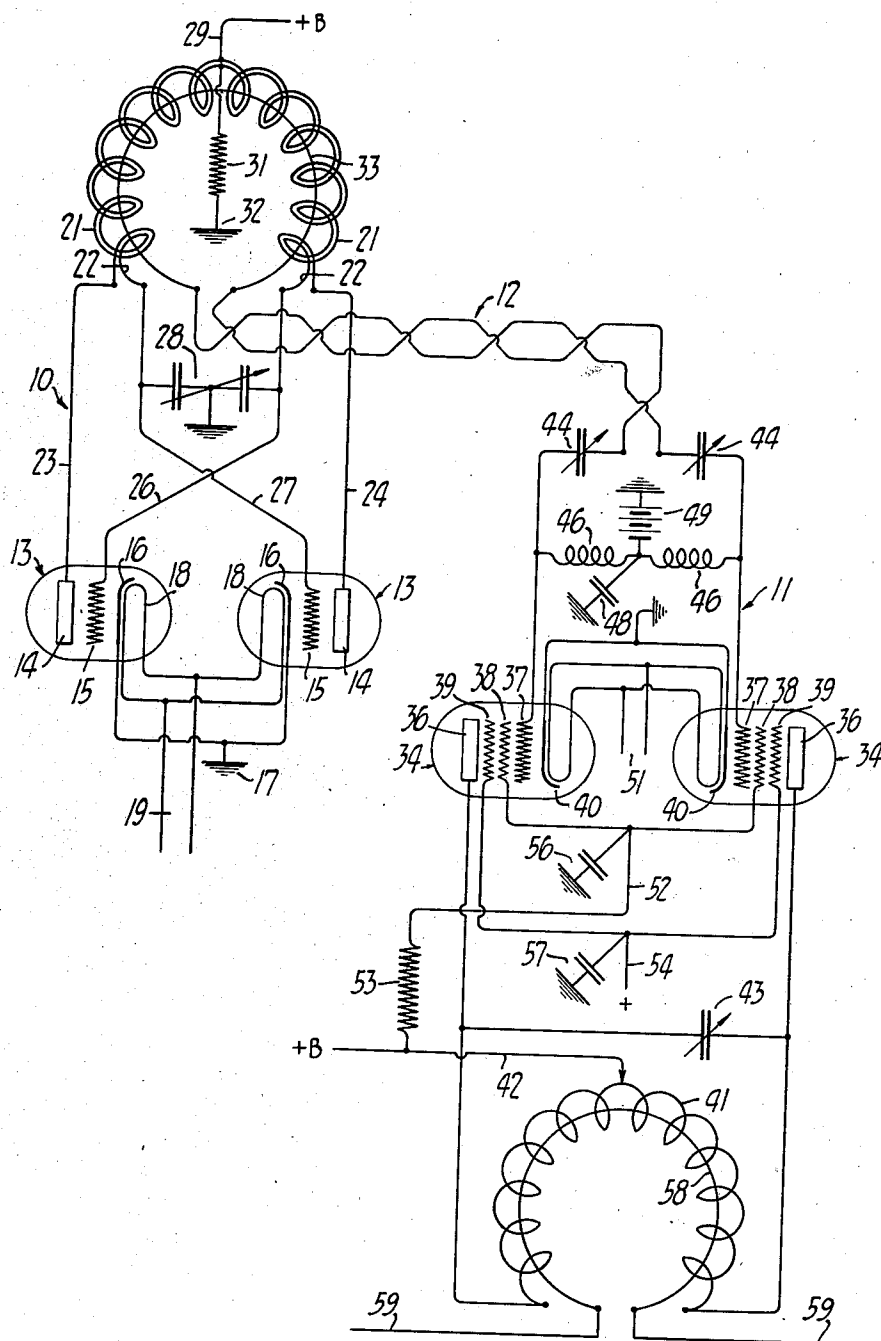
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RADIO TRANSMITTER

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RADIO TRANSMITTER

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This invention relates generally to radio frequency transmitters of the type making use of a master or pilot oscillator, coupled to a radio frequency power amplifier. More particularly it relates to radio transmitters adapted for the generation and transmission of radio signals of ultra high frequency, as for example from 30 to 60 megacycles.

It is an object of the invention to provide relatively simple apparatus of the above character, which will be stable with respect to the frequencies generated, without making use of special stabilizing means, such as a crystal control.

A further object of the invention is to provide an improved type of coupling between an oscillation generator and a power amplifier, whereby the frequency delivered by the power amplifier will remain stable and will not tend to drift.

Further objects of the invention will appear from the following description in which the preferred embodiment of the invention has been set forth in detail in conjunction with the accompanying drawing.

In carrying out the present invention I make use of a pilot or master oscillator of the vacuum tube or electron relay type, preferably with the anode and control circuits arranged in push-pull relationship. The power amplifier employed is also one of the electron relay type, and for efficient and economical operation it also preferably has its input and output circuits arranged for push-pull operation. For the purpose of transferring energy from the master oscillator to the input circuit of the power amplifier, I make use of a special form of current feed line, together with a special form of coupling between the ends of this current feed line, and the master oscillator and amplifier inputs respectively.

Referring to the drawing for a detailed description of the embodiment illustrated, the equipment as illustrated consists of a master oscillator 10, a power amplifier 11, and a current feed line 12 for delivering energy from the oscillator to the amplifier. The push-pull type of oscillation generator illustrated consists of electron relays 13, each having the usual anodes 14, grids 15, and heated cathodes 16. The cathodes are shown connected to common ground 17, and the heaters 18 for these cathodes are shown connected to a current supply circuit 19.

The inductances for the anode and grid circuits for the oscillation generator, are formed by the two coils 21 and 22. These coils are preferably formed by winding a pair of closely adjacent parallel wires helicoidally about a suitable

form, after which the helix is bent into the form of a toroid, with the ends of the toroid relatively close together. The terminals of the coil 21 are shown directly connected to the anodes 14, by the leads 23 and 24, while the terminals of the coil 22 are connected to the cross connected leads 25 and 27, which connect to the grids 15. A duplex grounded rotor condenser 28 is shown connected across leads 25 and 27, for tuning to the frequency desired. The mid-point on anode coil 21 is connected to the positive B-battery or plate supply lead 29, it being understood that the negative terminal of the B-battery or plate current source, is connected to ground. The mid-point of the grid coil 22 is shown connected to one end of a biasing resistor 31, the other end of which is connected to ground 32.

The oscillator described above can be modulated in any one of several ways, as for example grid modulation, plate modulation, etc., either by key or microphone.

For coupling one end of the current feed line 12 to the oscillation generator, I make use of one or two turns of a conductor 33, which is disposed axially of the toroidal shaped coils 21 and 22. The terminals of the coil 33 are adjacent the ends of the coils 21 and 22, and are directly or conductively connected to the two conductors of the current feed line 12. With such an arrangement there is substantially no mutual inductance between coil 33 and the coils 21 and 22, and the self inductance of coil 33 is relatively small. However, there is distributed capacitance between coil 33 and coils 21 and 22, that is capacitance distributed throughout the length of coil 33, and the coils 21 and 22.

The power amplifier 11 can vary in construction, but the type illustrated has been found to give good results. The two electron relays or vacuum tubes 34 employed are of the multiple control element type, and each includes the conventional plate or anode 36, control elements 37, and grids 38 and 39. Anodes 36 are shown connected to the terminals of a coil 41, which is likewise of toroidal form. The mid-point of this coil is shown connected to the positive plate current lead 42. The negative end of the plate current supply is connected to ground. The anode circuit is tuned by the condenser 43, connected in shunt with coil 41. The grids or control elements are directly coupled through the small variable condensers 44, with the two conductors of the current feed line 12. The grid circuit also includes the radio frequency chokes 46, which connect between the grids 37, and the grid bias

49. The cathodes 40 are connected to ground. The radio frequency by-pass condenser 48 connects between ground and the mid-point between chokes 46. Instead of employing a battery 49 or like source of biasing potential, equivalent means such as a grid biasing resistor, can be used. The heaters for the cathodes 40 are shown connected to a common current supply 51. The screen grids 38 are shown connected together, and to a lead 52, which connects with one terminal of the potential drop resistor 53. The other terminal of this resistor connects to the positive plate battery lead 42. The suppressor grids 39 are also connected together and to a common lead 54, which connects with a suitable source of potential bias or to ground. Radio frequency by-pass condensers 56 and 57 are shown connecting between leads 52 and 54, and ground.

For the purpose of coupling the anode circuit of the amplifier 11 with a tuned antenna system, I have shown a coiled conductor 53 disposed coincident with the axis of the coil 41. Coil 53 consists of one or more turns, and the terminals of this coil connects with the tuned antenna elements 59. Transfer of energy between coil 41 and coil 58 is largely by virtue of capacitance, in the same manner as previously described with respect to coils 33, at the oscillator end of the current feed line.

The transmitter described above operates as follows: The oscillation generator is tuned to a fixed definite frequency of operation, as for example between the range of from 30 to 60 megacycles, and the anode circuit of the power amplifier 11 tuned to the same frequency. Assuming that the load to which the amplifier connects is a tuned antenna, this antenna is likewise tuned to the same frequency of operation.

Energy from the oscillator 10 is transferred to the current feed line 12, by virtue of the distributed capacitance between coils 21 and 22 and the coil 33. At the amplifier end of the current feed line condensers 44 are adjusted to have a minimum capacitance without too great a sacrifice in transfer of energy to the amplifier. For a frequency of operation of about 40 megacycles, a pilot oscillator having an output of about 2 watts, and with an amplifier having an output of about 20 watts, it has been found that the condensers 44 may be adjusted to values of about 140 micro-microfarads each, with good results.

One of the chief characteristics of the apparatus described above is that the oscillator and the amplifier are isolated with respect to each other, insofar as detrimental reaction upon each other are concerned, while at the same time energy is effectively transmitted to excite the input of the amplifier. I attribute this chiefly to the type of coupling between the oscillator and the current feed line, and between the current feed line and the input of the amplifier. Although the coil 33 affords some inductance, there is negligible mutual inductance between this coil and the coils 21 and 22, and as previously pointed out the transfer of energy from coils 21 and 22 to coil 33, is by virtue of distributed capacitance. Furthermore since the self inductance afforded by coil 33 is of a relatively low value, that end of the current feed line is definitely not tuned with respect to the frequency of operation, and therefore the reactive impedance is relatively high for the frequency of operation. Also care should be taken to have the feed line 12 of such length that it is non-resonant to the frequency of operation. At the amplifier end of the current

feed line there is likewise an absence of inductive components for transfer of energy, and the energy transfer is through the relatively loose capacitive coupling afforded by condensers 44. The net result is that any slight swing in the frequency of operation of the oscillator does not immediately react to cause a swing in the frequency of operation of the amplifier, and conversely a tendency on the part of the amplifier to swing in frequency will not cause a corresponding swing in the frequency of the oscillator. The form of coupling provided between the anode circuit of the amplifier and the antenna elements 59, is likewise desirable, in that it prevents detrimental inter-action between the amplifier and the antenna system, which might tend to cause a swing in frequency.

Should one make use of a feed line 12 of such a character as to afford a condition of resonance or near resonance to the frequency of operation, the reactive impedance would be lowered, and there would be undesired inter-reaction between the oscillator and amplifier. Thus the length of the conductors forming the feed line should be such as to avoid resonance or near resonance, as previously explained, but to impress adequate potentials upon condensers 44 for transfer of energy.

In spite of the relatively loose coupling afforded between the oscillator and the amplifier, the arrangement described is capable of efficiently exciting the input of the amplifier, in a manner comparable to the arrangement heretofore employed, which made use of a relatively tight coupling. For example with an oscillator having a power output of about 5 watts, the amplifier 11 can be made to deliver an output of say 100 watts.

It will be apparent that additional amplifiers can be utilized in the transmitter described. For example one or more additional stages of amplification can be coupled between the output of the amplifier 11, and the antenna system. Likewise if desired an amplifier can be interposed between the master oscillator, and the coupling to the current feed line 12. In such event it will be apparent that the same type of coupling as that illustrated between the oscillator and amplifier 11, may be used to connect the master oscillator to the first amplifier, and if desired the first amplifier can be coupled in the same manner to the input of the second amplifier.

I claim:

1. In a radio frequency transmitter, an oscillation generator, said generator including grid and anode circuits tuned for generation of a definite radio frequency, said circuits including a toroidal shaped inductance, a conductor disposed axially of the toroid whereby said conductor for substantially its entire length is in capacitive relationship with respect to the inductance, a current feed line having one end of the same conductively connected to the terminals of said conductor, a radio frequency amplifier having input and output circuits, and means for capacitatively coupling the other end of the current feed line to the input circuit of the amplifier.

2. In a radio transmitter, a modulated oscillation generator, said generator including electron relays coupled with control and anode circuits in push-pull relationship for generation of radio frequency oscillations, said circuits including an inductance wound in toroidal form with a neutral midpoint, a conductor disposed axially of the toroid, the terminals of the conductor being adjacent the terminals of the inductance, a current

feed line having one end of the same connected to the terminals of the conductor, a radio frequency amplifier having input and output circuits, and means forming a capacitive coupling between the other end of the current feed line and the input circuit of the amplifier.

3. In a radio frequency transmitter, an oscillation generator making use of electron relays in push-pull relationship, together with control and anode circuits tuned to the frequency of operation, said circuits including an inductance wound toroidal fashion and having its midpoint connected to a point of neutral potential, a conductor disposed axially of the toroid and having its terminals adjacent the terminals of the inductance, a current feed line having one end of the same conductively connected to the terminals of said conductor, a radio frequency power amplifier having input and output circuits, said amplifier being likewise tuned to the same frequency as the frequency of operation of the oscillation generator, and including electron relays in push-pull relationship, and a pair of condensers serving to couple the terminals of the other end of the current feed line to the input circuit of the power amplifier.

4. In a radio transmitter, an oscillation generator having grid and anode circuits, said circuits including a tuned inductance, a conductor disposed in capacitive relationship with respect to said inductance, whereby capacitance between the conductor and said inductance is distributed substantially throughout the length of the con-

ductor and substantially throughout the length of the inductance, the coupling between the conductor and said inductance consisting substantially entirely of the reactance afforded by said distributed capacitance, a current feed line having one end of the same connected to the terminals of said conductor, a radio frequency amplifier having input and output circuits, said amplifier being tuned to the same frequency as the frequency of operation of the oscillation generator, and means for capacitatively coupling the other end of the current feed line to the input circuit of said amplifier.

5. In a radio transmitter, an oscillation generator having grid and anode circuits, said circuits including an inductance formed by a coiled conductor of substantial length, a second conductor extending in proximity with the coiled conductor whereby capacitance between the second conductor and the several convolutions of the coiled conductor affords an electrical coupling, said capacitance forming substantially the sole coupling between the second conductor and said oscillation generator, a current feed line having one end of the same connected to the terminals of said second conductor, a radio frequency amplifier having input and output circuits, said amplifier being tuned to the same frequency as the frequency of operation of the oscillation generator, and means for coupling the other end of the current feed line to the input circuit of said amplifier.

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