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ULTRA HIGH FREQUENCY TRANSMITTER

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## ULTRA HIGH FREQUENCY TRANSMITTER

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6 Claims. (Cl. 250—36)

This application is a division of our application Serial No. 78,124, filed May 6, 1936, now United States Patent No. 2,174,154, granted September 26, 1939.

This invention relates to ultra high frequency transmitters, and more particularly to a high quality television transmitter for efficiently transmitting signal impulses whose frequencies cover a wide range from approximately twenty cycles to one and one-half million cycles. Such frequencies are known as "video" frequencies.

The complete transmitting circuit of the invention comprises, in brief, a push-pull master oscillator whose frequency is controlled by a concentric line resonator, there being coupled to the output of the oscillator, a push-pull power amplifier to whose grids are coupled the amplified "video" frequencies of an extremely wide band. The oscillator is arranged to generate oscillations whose frequencies are of the order of 177 megacycles corresponding to 1.695 meters. In the output of the power amplifier and coupled to it through a novel type of Lecher wire transformer is a monitor circuit for checking the operation of the transmitter. Among the features of the invention are: The tuned concentric line resonator whose frequency is variable by changing at will the capacity between the conductors, and the novel tuned circuit whose uniformly distributed inductance is mostly shielded except for a portion coupled to the power amplifier circuit.

A complete description of the invention follows, accompanied by a drawing, wherein the single figure shows schematically a complete transmitting system including master oscillator, power amplifier, modulator and monitor circuits.

Referring to the drawing in more detail, there is shown a master oscillator circuit comprising a pair of electron discharge devices 1, 2 arranged in push-pull relation. There is provided a filament source of supply 3 connected in common to the filaments of both electron discharge device oscillators. Each filament has in series with each of its legs an inductance 4 which is of such value that, in cooperation with the tuning condenser 5 and series connected by-pass condensers 6 for radio frequencies, proper regeneration is obtained in the oscillator for best efficiency. The equivalent inductive reactance of 4 is variable by the condenser 5 in shunt with it. A filament return bias resistor 7 is shown connected between one leg of the filament and ground.

Connected to the grids of the oscillator devices 1, 2 is a tuned concentric tubular conductor resonator line circuit comprising an inner conductor 9 and an outer conductor 10 for controlling the frequency of the oscillations generated by the master oscillator. This frequency control resonator is generally of the type described in the article by Clarence W. Hansell, published in the A. I. E. E., August, 1935, pages 852–857, except for certain features which will appear more fully hereinafter. The grids of the electron discharge devices 1, 2 are inductively coupled to the inner conductor 9 of the line by means of two single-turn coils placed radially in the space between the inner and outer conductors and so connected as to impress radio frequency voltages of opposite phase on the grids of the vacuum tubes. In order to reduce the inductive reactance of the grid circuits of both vacuum tubes, so as to keep the regeneration of proper phase, there is provided a parallel shunt circuit 8. Inner conductor 9 of the tuned concentric line resonator is, in practice, made to have a length slightly less than one-quarter of the length of the operating wave, and the capacity between the top 11 of the resonator and the top of the inner line 9 varied to give the desired frequency. The inner conductor comprises as a part thereof a pair of plates 12, 13 which are connected together conductively by a screw and a phosphor bronze spring 15. In one position, both plates 12 and 13 may be made to appear like a single plate, in which case there will be minimum capacity between the inner conductor 9 and the upper part 11 of outer conductor 10 with a consequent maximum frequency of oscillation in the resonator. At the other extreme position, by turning screw 16 connected to shaft 14, both plates will provide a maximum capacity between the inner conductor 9 and plate 11 with a consequent minimum frequency of oscillations in the resonator.

The output of the master oscillator comprises a parallel tuned circuit consisting of a variable condenser 17 and an inductance 18, 18', the inductor of which has substantially uniformly distributed constants. This inductor is composed of two copper rods 18 and 18' of equal length and enclosed by concentric copper sleeves 19, 19' which are grounded. One conductor 18 is connected to the anode of tube 2 while conductor 18' is connected to the anode of tube 1. The opposite ends of 18 and 18' are connected together by any suitable conductor 44 so positioned over ground sheet 20 as to make its capacity per unit length the same as the concentric conductors 19—18 and 19'—18'. The conductor 44 must be long enough to provide sufficient cou-

pling to the power amplifier grid circuit. In view of the physical configuration of inductance 18, 18', which includes two parallel connected portions and a straight portion 44, it will herein be referred to as a Lecher wire output. The length of this Lecher wire output, as measured from the anodes of the electron discharge device 1, 2 to the center point of portion 44 of the Lecher wire system, is made to be about one-eighth of a wavelength in order to prevent reaction upon the master oscillator device due to modulation of the power amplifier. The load on the master oscillator, which in this case is the power amplifier grid circuit, may be replaced by an equivalent series resistance (variable over the modulation cycle) in series with the Lecher wire output 18, 18' of the two master oscillator electron discharge devices. The inductive reactance of the output 18, 18' at the operating frequency is fairly low, of the order of 100 ohms, and hence the equivalent series load resistance may be made small, about two ohms. Consequently, any variation of the series load resistance of two ohms due to modulation will have little effect on the master oscillator anode inductive reactance of 100 ohms.

Coupled to the straight portion 44 of the Lecher wire output 18, 18' are a pair of power amplifier electron discharge devices 21, 22 arranged in push-pull relation to each other. The filament circuits of the tubes 21, 22 are heated by a common source of energy 23 which feeds the filaments through radio frequency choke coils 24. Condensers 25 serve to by-pass the radio frequency energy in the filament connections to ground. A pair of neutralizing condensers 27 cross-connect the grids of the devices 21, 22 to the anodes of the associated devices in the conventional manner. The electron discharge devices, 21, 22, are capable of oscillating at frequencies as high as 400 megacycles per second, hence it is necessary to make the leads from the grid and anodes to the neutralizing condensers as short as possible. If these leads are made even moderately long, the relatively low inductance of the leads will have an appreciable inductive reactance at frequencies of the order of 300 megacycles. This inductance may be sufficiently high to allow the tubes to oscillate at some very high frequency. The ideal condition is to have zero reactance between the grid and neutralizing condenser and between the plate and neutralizing condenser.

The center tape of the power amplifier grid circuit is connected through a resistance 41 to the anodes of the modulator tubes 40 which are maintained at a positive potential of about 250 volts. However, the filaments of the power amplifier devices 21, 22 are maintained at a positive potential of 500 volts relative to ground, and consequently it can be said that the grids of the power amplifiers are at an equivalent negative potential of 250 volts relative to the filaments thereof. This arrangement of connecting the anodes of the modulation tubes conductively to the power amplifier filament return bias by 250 volts simplifies the design of the circuit greatly.

The output circuit of the power amplifier comprises a symmetrically bent Lecher wire system comprising two halves 28, 28' connected to which, in parallel, is a variable condenser 29 for tuning the output. The two halves 28, 28' are provided merely to give symmetry to the physical configuration of the circuit, so that in case there is any influence on one half of the tuned circuit by the adjacent filament of internal tube elements, there will also be a similar effect on the other half of the Lecher wire output. Of course, it will be understood that, if desired, one-half of the Lecher wire output for the power amplifier can be dispensed with.

Coupled to the power amplifier output through leads 30 there are shown a pair of terminals which connect with any suitable utilization circuit such as an antenna. It will be observed that leads 30 are inductively connected to the Lecher wire system 28, 29 by means of a loop, the center point of which is grounded at 31. This ground connection serves to prevent push-push voltages on the antenna system. Also coupled to leads 30 is a step-down transformer comprising a U-shaped loop 32 whose legs are preferably each a quarter wavelength long, as indicated, although the length of each leg can be any odd number of quarter wavelengths long. This loop is the equivalent of a step-down transformer and serves to step-down the impedance at the antenna terminals from a high value to the low value at the lower end of the loop, which is shown inductively coupled to a diode 33. This U-shaped step-down transformer, it will be observed, is also grounded at the center point 34 to prevent push-push oscillations. Loop 32 is merely a coupling link between the output of the power amplifier and a monitor circuit comprising diode 33 whose filament is closely coupled inductively to the step-down transformer 32. In the output circuit of diode 33, which in practice may comprise an RCA type 955 tube, is a filter circuit 35, here shown conventionally, in turn coupled to a voltmeter 36. Circuit 35 serves to filter out the carrier frequency from the voltmeter. The purpose of the monitoring circuit is to measure the amplitude of the carrier from the power amplifiers, and also to measure the modulation on the carrier. It should be noted that the quarter wavelength long step-down transformer 32 presents a high impedance to the antenna terminals in order to prevent loading.

The modulator circuit shown within the box 37 serves to amplify the video frequency input from the value of .35 volt rms, as supplied from the studio to the first amplifier, to about 80 volts rms as effective in modulating the grids of the electron discharge devices 21, 22. For this purpose there is provided a first pentode low power tube 38, which in practice may be an RCA 6C6, which drives a second pentode tube 39 whose output is, in turn, connected to the grids of two other pentode tubes 40 in parallel. From the output of pentode tubes 40 is a connection to the grids of the power amplifier. In series with this connection is a resistor 41 to prevent push-push oscillations in the power amplifier. This resistor acts as a large series reactance to voltages of the carrier frequency and has small stray capacitance for voltages of the video frequencies, and damps high frequency push-push parasitic oscillations. This resistor may, if desired, be omitted altogether, in which case the center point of the grid inductance will be directly connected to the modulator plates by a very fine (small diameter) resistance wire. This fine resistance wire acts as a large series reactance to voltages of the carrier frequency, and has small stray capacitance for voltages of the video frequency, thus damping received push-push oscillations. Electron discharge devices 39 and 40 may, in practice, comprise RCA type 802 tubes. All pentode tubes are of the well-known type

which include besides the anode and cathode, a control grid and a suppressor grid connected in known fashion. Coupled to the anodes of the two parallel connected video modulators **40** is a load resistor **42** which, in one embodiment tried satisfactorily in practice, had a value of 2250 ohms, and an inductance **43** which serves to compensate for the tube and circuit output capacity. The video frequencies supplied from the studio may have a very wide range extending from, let us say, 20 cycles to 1,500,000 cycles.

In the operation of the transmitter circuit, the voltage impulses from the master oscillator, which have a frequency of the order of 177 megacycles per second, are impressed on the power amplifier grids in push-pull relation, and amplified through amplifiers **21, 22**. The degree of amplification is varied by varying the bias of the grids of **21, 22** in parallel in accordance with voltage impulses which range in frequency from 20 cycles per second to 1.5 megacycles per second, supplied by the television pick-up mechanism and amplified by amplifier circuit **37**. The resulting amplitude modulated signal is sent out over the air through the antenna circuit coupled to the Lecher wire output of the power amplifier. The monitor circuit **33, 35, 36** serves to measure the amplitude and degree of modulation of the carrier.

Although the invention has been described hereinabove with reference to a particular embodiment, it will be understood, of course, that the scope thereof is not limited thereto since the various features thereof are capable of being used in other circuit ararngements and in modified forms without departing from the spirit of the present invention.

What is claimed is:

1. A tuned oscillatory circuit comprising an inductance in the form of a wire loop having uniformly distributed constants and a condenser coupled to the terminals of said loop, a utilization circuit coupled to said oscillatory circuit by means of a linear wire paralleling a portion of said loop, and means for shielding the greater part of the remaining portion of said loop.

2. A tuned oscillatory circuit comprising an inductance in the form of a wire loop having uniformly distributed constants and a condenser coupled to the terminals of said loop, a utilization circuit coupled to said oscillatory circuit by means of a linear wire paralleling a portion of said loop, and means for shielding the greater part of the remaining portion of said loop, the length of each half of said wire loop from the center thereof to said condenser being approximately one-eighth the length of the operating wave.

3. An oscillator comprising a pair of electron discharge devices connected in push-pull relationship, each of said devices having an anode, cathode and a control electrode, connections between said devices for coupling corresponding electrodes together, said connection between said anodes including a U-shaped loop, a shield at a relatively fixed radio frequency potential surrounding each leg of said U-shaped loop, and means shielding only one side of the connection extending between the legs of said loop for making the capacity per unit length of said connection substantially the same as said legs.

4. In combination, a pair of electron discharge devices connected in push-pull relationship, each of said devices having an anode, a cathode and a control electrode, connections between said devices for coupling corresponding electrodes together, the connection between said anodes comprising a tuned circuit in the form of a wire loop having uniformly distributed constants and a condenser coupled to the terminals of said loop, a utilization circuit coupled to said oscillatory circuit by means of a linear wire paralleling a portion of said loop, and means for shielding the greater part of the remaining portion of said loop.

5. A tuned circuit comprising an inductance in the form of a loop having uniformly distributed constants and a capacitor at the terminals of said loop, a utilization circuit coupled to said tuned circuit by means of a conductor in the magnetic field of a portion of said loop, and means for shielding the greater part of the remaining portion of said loop.

6. A tuned circuit comprising an inductance in the form of a U-shaped loop having uniformly distributed constants and a capacitor across the legs of said loop at points removed from the connection extending between said legs, a utilization circuit coupled to said tuned circuit by means of a conductor paralleling a portion of said loop, and means for shielding the greater part of the remaining portion of said loop.

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