

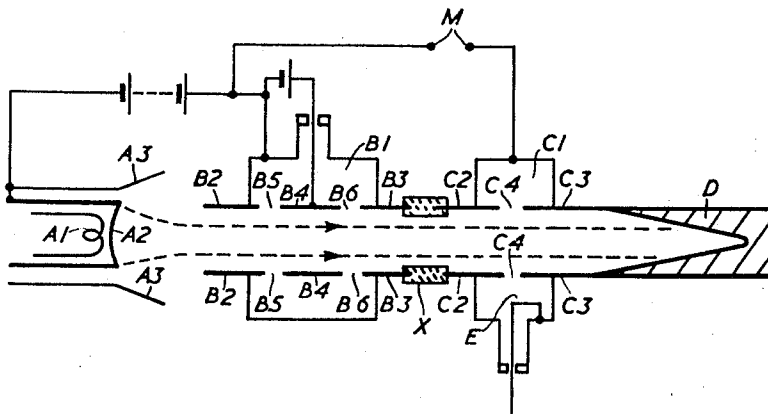
July 24, 1962

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3,046,492

KLYSTRON MICROWAVE OSCILLATOR WITH PARTICULAR KEYING MEANS

Filed April 17, 1959



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3,046,492

## KLYSTRON MICROWAVE OSCILLATOR WITH PARTICULAR KEYING MEANS

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Filed Apr. 17, 1959, Ser. No. 807,222

Claims priority, application Great Britain Apr. 30, 1958

4 Claims. (Cl. 331—83)

This invention relates to microwave oscillators and has for its object to provide improved Klystron microwave oscillators capable of providing modulated or keyed radio frequency outputs.

There are various known means whereby a reflex Klystron oscillator may be keyed or modulated by applied pulses so as to provide output pulses of microwave energy. Known modulated oscillators of this nature, however, have the defect that the output pulses are not precisely co-related to the modulating pulses, the leading edges of the output pulses exhibiting a random "jitter" in relation to the leading edges of the modulating pulses instead of being, as is desired, in fixed time relation therewith. Another defect which is commonly experienced in known arrangements of this nature wherein the reflector electrode voltage is varied or adjusted to vary or adjust frequency (as is commonly done) is that such electronic frequency adjustment is also accompanied by undesired changes in the shape of the output microwave pulse and/or by undesired shifts in the time relation between the leading edge of the output pulse and the leading edge of the modulating pulse producing it.

The present invention seeks to avoid the above mentioned defects and to provide improved microwave oscillators which can be pulsed or similarly modulated and which shall be such that "jitter" of the leading edges of the output pulses is reduced or eliminated while voltage adjustment for adjusting frequency can be made without undesired accompanying distortion and/or phase shift of the output pulses.

According to this invention a Klystron microwave oscillator tube comprises an electron beam source, a continuous wave resonant oscillator section including a resonant cavity and adapted to modulate the electrons of the beam from said source in velocity and space charge density in accordance with a modulating frequency, a resonant output section including a resonant cavity beyond said oscillator section in the direction of beam travel and provided with means for taking off radio frequency energy from the beam, a collector electrode for receiving the beam, and means, connected between said oscillator section resonant cavity and said output section resonant cavity, for controlling the fraction of the beam permitted to pass from said oscillator section to said output section.

The means adapted to control the fraction of the modulated beam permitted to pass from the oscillator section to the output section may comprise means for applying a controllable potential between a part of the former section and a part of the latter section, or it may comprise a control electrode adapted to receive a controllable potential to control the electron flow between the two sections.

The oscillator section preferably comprises a resonant cavity surrounding a portion of the electron beam with a so-called drift tube, through which said beam passes, within it, said beam interacting with the field in the cavity through gaps left at the two ends of said drift tube. The output section preferably comprises a resonant cavity also surrounding a portion of the electron beam which passes through a tube extending across said cavity and having

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an intermediately positioned gap through which said beam interacts with the field in said cavity, means being provided for taking off output radio frequency energy from said cavity.

The invention is illustrated in the accompanying drawing which is a schematic representation of one embodiment.

Referring to the drawing, the Klystron tube therein shown has, within an evacuated envelope (not shown) an electron gun comprising the usual cathode heater A1, cathode A2 and focusing and accelerating electrode A3. Magnetic or other focusing means (not shown) may be provided in manner well known per se. The beam from the gun passes through a continuous wave oscillator section comprising a microwave resonator B1 with entry and exit tubes B2 and B3 and a centrally situated drift tube B4. All these tubes are co-linear and are shown as of the same diameter. A ring gap B5 is left between the tubes B2 and B4 and a ring gap B6 is left between the tubes B4 and B3. Suitable operating potentials are applied in accordance with known principles. The beam, when it emerges through the tube B3, will be modulated in velocity and space charge density at a microwave frequency determined primarily by the dimensions of the cavity B1 though, as is well known, a measure of control is obtainable by suitable variation of applied potentials.

The modulated beam emerging through the tube B3 next passes through the output section which consists of a resonant cavity C1 with entry and exit tubes C2 and C3, a ring gap C4 being left between them. These tubes are again shown as co-linear and of the same diameter as the tubes B2, B4 and B3. Between the exit tube B3 of the oscillator section and the entry tube C2 of the output section is an insulator X. D is the final or collector electrode. Modulating or keying pulses, normally rectangular in shape, are arranged to be applied at terminals M to the oscillator and output sections and pulsed microwave output is taken from the output section cavity C1 by means such as the output arrangement well known per se indicated at E.

With the arrangement of the drawing, the electron beam from the cathode interacts through the gaps B5, B6 with the field in the cavity B1 which cavity oscillates at a frequency determined primarily by its own geometry, but also to some extent by the direct current voltage applied to the drift tube B4. The fraction of the modulated beam passing out through the tube B3 which is permitted to enter the output section through the tube C2 is determined by the potential difference applied between the oscillator and output sections, i.e. by the potential applied at terminals M. If the output section is at a sufficiently negative voltage with respect to the oscillator section, no part of the beam will reach it at all and there will be no output. Microwave output will occur when the output section is at the same voltage as the oscillator section or is positive with respect thereto and accordingly modulating or keying action to pulse the output radio frequency may be obtained by applying suitable pulses of potential between the terminals M. It will be seen that the defects of the previously known arrangements are avoided and that the output pulses will be, for all practical purposes, unaffected in their timing or shape by voltage adjustments effected for electronic control of frequency.

Instead of the arrangement shown in the drawing for controlling the fraction of the beam passing from the oscillator section to the output section of the tube, other suitable means may be employed, e.g. a grid or other control electrode insulated from the drift tube could be provided between the oscillator and output sections and keying control effected by varying the voltage on the said control electrode.

We claim:

1. A Klystron microwave oscillator tube comprising an electron beam source, a continuous wave resonant oscillator section adapted to modulate the electrons of the beam from said source in velocity and space charge density in accordance with a modulating frequency, a resonant output section beyond said oscillator section in the direction of beam travel and provided with means for taking off radio frequency energy from the beam, a collector electrode for receiving the beam, and voltage control means situated between said oscillator section and said output section, adapted to control the electron current in the beam and thereby the fraction of the beam permitted to pass from said oscillator section to said output section, said oscillator section comprising a resonant cavity, a drift tube in said cavity having its ends spaced from said cavity to define gaps and surrounding a portion of the electron beam, said beam inter-acting with the field in the cavity through said gaps.

2. A Klystron microwave oscillator tube comprising an electron beam source, a continuous wave resonant oscillator section including a resonant cavity and adapted to modulate the electrons of the beam from said source in velocity and space charge density in accordance with a modulating frequency, a resonant output section including a resonant cavity beyond said oscillator section in the direction of beam travel and provided with means for taking off radio frequency energy from the beam, means insulating said cavities from each other, a collector electrode for receiving the beam, and voltage control means connected to said oscillator section resonant cavity and

to said output section resonant cavity for applying a control potential between the resonant cavity of the oscillator section and the resonant cavity of the output section to control the electron current in the beam, and thereby to control the fraction of the beam permitted to pass from said oscillator section to said output section.

3. A tube as claimed in claim 2, wherein the oscillator section comprises a resonant cavity surrounding a portion of the electron beam and a drift tube in said oscillator resonant cavity spaced from the cavity to define gaps at the two ends of said tube, said beam passing through said drift tube and interacting with the field in the cavity through gaps at the two ends of said drift tube.

4. A tube as claimed in claim 2, wherein the output section comprises a resonant cavity surrounding a portion of the electron beam which passes through a tube extending across said cavity and having an intermediately positioned gap through which said beam interacts with the field in said cavity, and means for deriving radio frequency energy from said cavity.

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