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VELOCITY MODULATION TUBE

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FIG. 1.

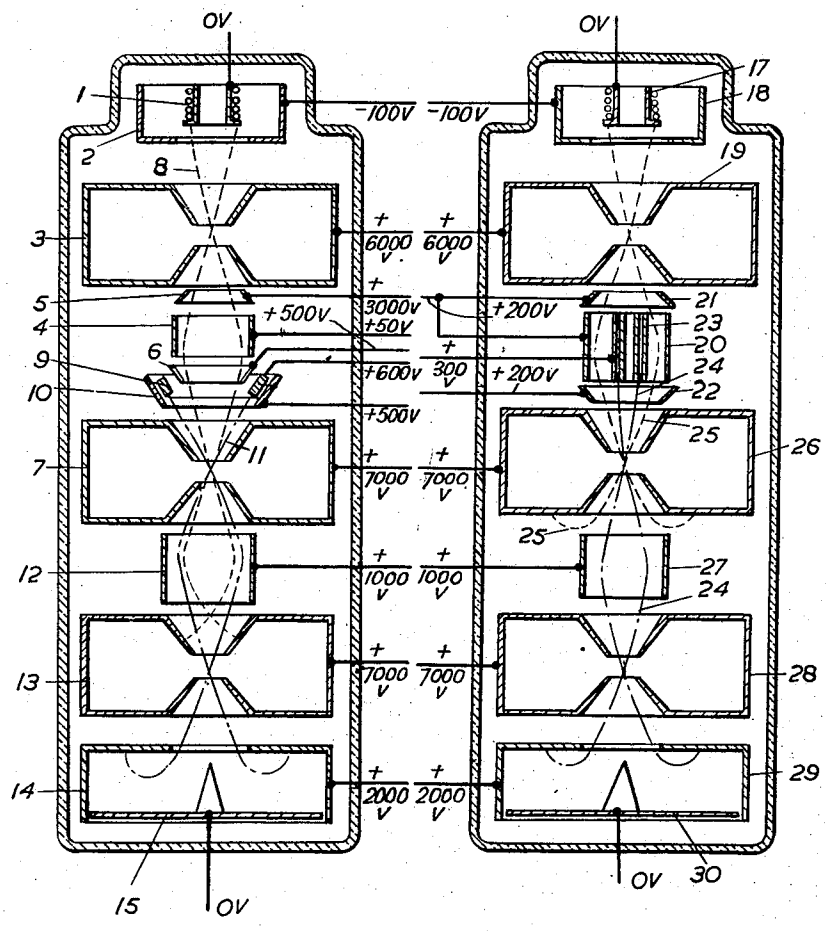


FIG. 2.

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VELOCITY MODULATION TUBE

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The present invention relates to velocity modulation tubes and in particular to such tubes used as amplifiers for ultra high frequencies.

According to features of the invention the velocity modulation tube according to the invention comprises two units and two electron beams. The electrons of the first beam are velocity modulated in a first modulation resonator and excite a catcher resonator. This catcher resonator operates as a modulation resonator for a second electron beam with a modulation factor higher than that of the first modulation resonator, and the electrons of this second beam excite a second catcher resonator.

With this double modulation process it is possible to secure a higher amplification factor for the same output power and the tube may be considered as comprising a power amplifier preceded by a pre-amplifier.

The above mentioned and other features and objects of this invention will become more apparent and the invention itself, though not necessarily defined by said features and objects, will be best understood by reference to the following description of an embodiment of the invention taken in connection with the accompanying drawings wherein:

Fig. 1 shows a first embodiment, and

Fig. 2 shows a second embodiment of the invention.

Referring now to Fig. 1 this figure shows a first embodiment comprising a first cathode 1 whose potential is chosen as a reference potential for the remainder of the description, a first concentrating or Wehnelt electrode 2 at a potential of for instance —100 volts, a first modulating cavity resonator 3 at a high potential, for instance 6000 volts, a drift electrode 4 at a low potential, for instance +50 volts, in which the electrons collect into bunches.

This drift electrode 4 is provided with two auxiliary electrodes 5 and 6 of conical shape intended to focus the electron beam and which are brought respectively to potentials of +3000 volts for electrode 5 and +500 volts for electrode 6, for example.

The low intensity electron beam 8 from cathode 1 flows through the first part of the tube including a second cavity resonator 7 to which it transfers high frequency energy.

After the drift electrode is provided a second circular cathode 9 at a potential of, for instance +600 volts, which is provided with a Wehnelt electrode 10 at a potential 100 volts lower than the cathode, i. e. +500 volts.

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The two electron beams 8 and 11 flow through resonator 7 which operates as a catcher resonator for the first beam 8 and as a modulation resonator for the second beam 11. The resonator 7, excited by beam 8 after the bunching of the electrons in the drift electrode 4, velocity modulates the second beam and the tube works as an amplifier in which the second beam 11 works in a manner similar to beam 8 in the first part of the tube structure. A second drift electrode 12 is provided to this effect following resonator 7 brought to a relatively low potential of for instance +1000 volts, in which the electrons are slowed down and group themselves into bunches. The potential and shape of the various electrodes are so chosen that beam 11 be focalised at the level of the second catcher resonator 13. On the contrary, the electrons of the first beam 8 are collected by the third resonator 13. The first beam is of low intensity and may be collected by the high potential resonator 13 without decreasing substantialy the overall efficiency of the tube.

Since the angular opening of the second beam 11 is larger it is, on the contrary, focalised in the opening of the third resonator 13 brought to a potential of +7000 volts for instance, and which operates as a catcher resonator. The beam finally reaches a collector electrode 14 at a relatively low potential, for instance 2000 volts. A reflector 15 at a nul or negative potential, deflects the beam 11 toward collector 14.

Fig. 2 shows another embodiment of the invention comprising, as in the first embodiment, a cathode 17, a Wehnelt electrode 18 at a negative potential, for instance —100 volts, a first resonator at a potential of +6000 volts for instance, a first drift electrode 20 at a low potential of, for instance, 200 volts, provided with two auxiliary electrodes 21 and 22 brought to the same potential of 200 volts for instance, which direct the beam into the drift tube 20.

Inside tube 20 is provided a second annular cathode 23 at a potential of, for instance 300 volts, which generates a second conical beam 24 with a smaller angle than the first beam 25.

The two beams flow through the second resonator 26 which works as a catcher resonator for the first beam and as modulation resonator for the second beam.

The second beam 24 flows through a second drift electrode 27 at a relatively low potential, 1000 volts for instance, in which the electrons are slowed down and grouped into bunches. The beam then flows through a catcher resonator 28 at a potential of, for instance, +7000 volts

and is collected by a collector electrode 29 brought to a reduced potential of, for instance, +2000 volts and which is provided with a reflector 30 at a nul or negative potential for repulsing the electrons towards the collector electrode.

According to the second embodiment the first beam has an angular opening greater than the second beam and at the output of the second resonator the first beam cannot penetrate into the second drift electrode and is collected by the said second electrode which is at a high potential, the overall efficiency is however not substantially affected on account of the low intensity of this first beam.

The tube which has just been described constitutes an output amplifier preceded by a pre-amplifier in which the modulation resonator of the output amplifier coincides with the catcher resonator of the pre-amplifier.

The same means which have been set forth in relation with Figs. 1 and 2 may be used for making tubes having more than two stages. The size of such tubes is therefore greatly reduced, moreover the tubes made according to the invention have the advantage of overcoming the difficulties of high frequency coupling between two amplifiers.

While we have described above a particular embodiment of our invention for purpose of illustration it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

What we claim is:

1. A velocity modulation tube, comprising a first electron gun for projecting a first beam along a beam path, a first cavity resonator adjacent said first gun and about said beam path for velocity modulating said first beam, a second electron gun adjacent and beyond said first resonator for projecting a second beam along said beam path, a second cavity resonator adjacent said second gun and about said beam path for extracting energy from said first beam and for velocity modulating said second beam, and a third cavity resonator adjacent said second resonator and about said beam path for extracting energy from said second beam.

2. A velocity modulation tube, comprising a first electron gun for projecting a first beam along a beam path, a first cavity resonator adjacent said first gun and about said beam path for velocity modulating said first beam, a second electron gun adjacent and beyond said first resonator and about said beam path for projecting a second beam along said beam path, said first gun having means for focussing said first beam to pass through said second gun, a second cavity resonator adjacent said second gun and about said beam path for extracting energy from said first beam and for velocity modulating said second beam, a drift tube adjacent said second cavity resonator and about said beam path for stopping said first beam, and a third cavity resonator adjacent said drift tube and about said beam path for extracting energy from said second beam.

3. A velocity modulation tube according to claim 2 further comprising means by which a potential difference may be applied between said drift tube and said second cavity resonator to cause the electrons in said first beam to be collected by said second cavity resonator before passage therethrough and means beyond said second resonator for collecting the electrons from said second beam.

4. A velocity modulation tube, comprising a first electron gun for projecting a first beam along a beam path, a first cavity resonator adjacent said first gun and about said beam path for velocity modulating said first beam, a second electron gun disposed in said beam path adjacent and beyond said first resonator for projecting a second beam along said beam path, said first gun having means for focussing said first beam past said second gun, a second cavity resonator adjacent said second gun and about said beam path for extracting energy from said first beam and for velocity modulating said second beam, a drift space defining means adjacent said second resonator for stopping said first beam, and a third cavity resonator adjacent said drift space defining means and about said beam path for extracting energy from said second beam.

5. A velocity modulation tube according to claim 4 further comprising means by which a potential may be applied to said drift space defining means to reflect said first beam for collection by said second resonator and means adjacent said third resonator for collecting said second beam.

6. A velocity modulation tube, comprising a first velocity modulation structure having a modulating cavity resonator and a catcher cavity resonator, a first electron gun for projecting a first beam of electrons through said resonators and means adjacent said catcher resonator for collecting electrons in said first beam, and a second velocity modulation structure including a second electron gun mounted between said modulating and catcher resonators of said first structure for projecting a second electron beam through said catcher resonator and further including a second catcher cavity resonator adjacent said first beam collecting means and about the path of said second beam.

7. A velocity modulation tube comprising a first velocity modulation structure having a modulating cavity resonator and a catcher cavity resonator, a second velocity modulation structure, the catcher cavity resonator of said first structure constituting a modulating cavity resonator for said second structure, said second structure having a catcher resonator, a first electron gun disposed adjacent the modulating cavity resonator of said first velocity modulating structure for projecting an electron beam through said first velocity modulation structure and a second electron gun disposed between the modulating and catcher cavity resonators of said first velocity modulating structure for projecting an electron beam through the said second velocity modulation structure.

8. A velocity modulation tube comprising a first electron beam source, a first velocity modulation structure having a modulating and a catcher resonator disposed in alignment with said first beam source, a first means for focusing the electron beam of said first source through said cavity resonators, a second electron beam source disposed between the modulating and catcher resonators of said first velocity modulating structure, a second velocity modulation structure having a catcher resonator, a second means for focusing the electron beam of said second source through the catcher resonator of said first modulation structure thence through the catcher resonator of said second structure.

9. In a velocity modulation tube, a first elec-

tron beam source, a second electron beam source disposed in tandem relation with respect to said first beam source for beam travel along a common path, means to modulate said first beam, means disposed adjacent said common path to transfer the modulation of said first beam to said second beam, and means adjacent the path of said second beam to receive modulated energy from said second beam.

10. In a velocity modulation tube according to claim 9, wherein the means to transfer the modulation of said first beam to said second beam includes a cavity resonator disposed adjacent the paths of both said first and said second beams.

11. In a velocity modulation tube according to claim 9, wherein each of the three means recited therein includes a cavity resonator.

12. In a velocity modulation tube according to claim 11 further including focusing electrodes to direct said first beam through the first and second resonators only and to direct the second beam through the second and third resonators only.

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