

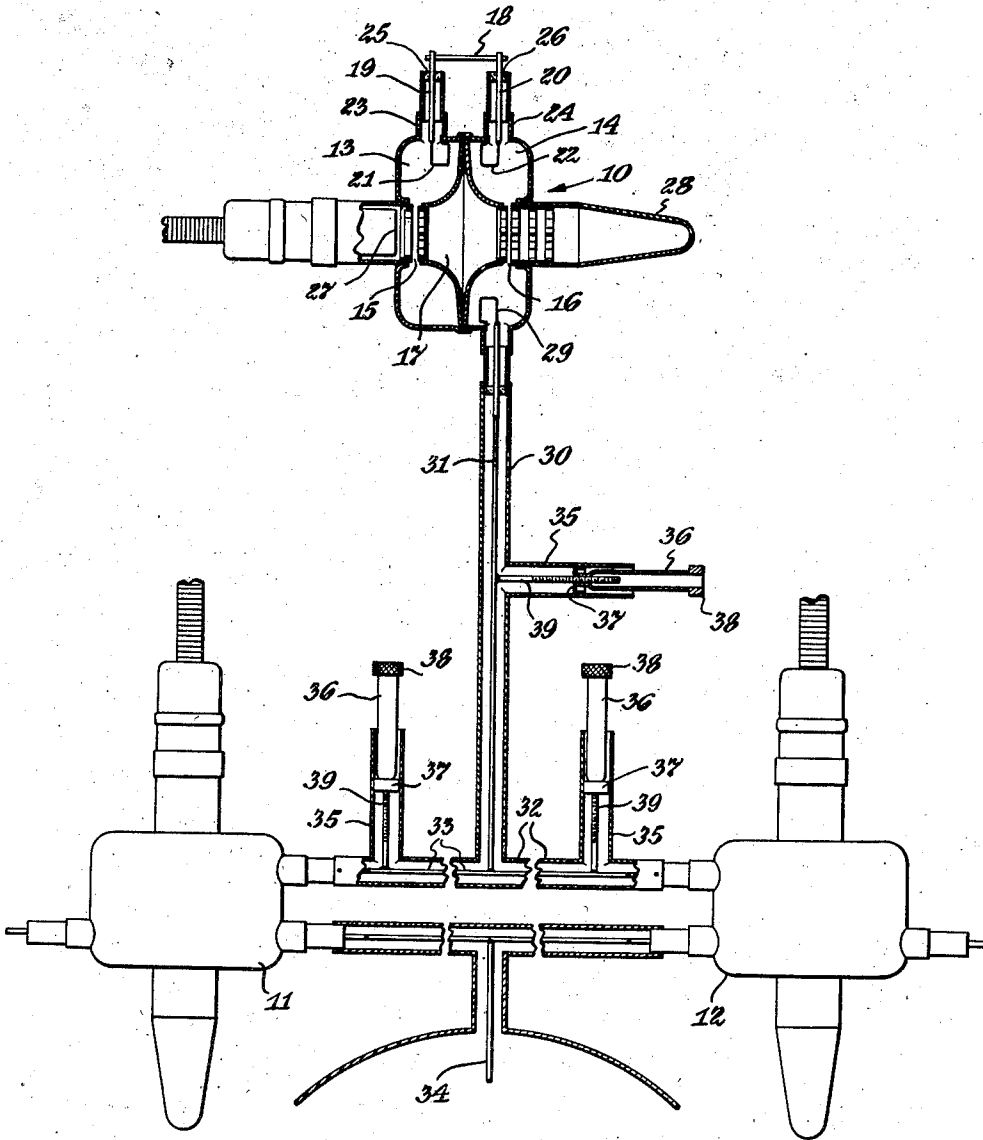
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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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1 Claim. (Cl. 179-171)

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This invention relates to electron discharge devices, and particularly to discharge devices of the type incorporating hollow-body resonators.

Physical considerations, as well as electrical and electronic, introduce limitations on the output of a discharge device of the designated class, both as to power developed, amplification, and other characterizations. The problem accordingly presents itself as to how to overcome such limitations and produce the desired output which is required above the productive capabilities of the discharge device. It is recognized in the art that hollow-body resonators must be designed with strict regard to the wave-length or frequency and the shorter such wave-length, then the smaller the resonators must be. However, in making resonators smaller, other parts have to be reduced in size and output accordingly suffers.

An object of the present invention is to overcome deficiencies of the prior art as to limitation of power output obtainable from electron discharge devices of the hollow-body resonator type.

Another object of the present invention is to obtain desired power output by grouping a plurality of the said discharge devices in such manner that the individual outputs are combined as the augmented usable final output.

A further object of the invention is to effectively match the wave output of one device with respect to oscillations of one or more supplemental devices to obtain an additive relationship of wave propagation and output.

A still further object of the invention is to obtain matching by exteriorly operated adjusting mechanism.

Yet other objects of the present invention will appear to those skilled in the art as the description progresses, both by direct statement thereof and by implication from the context.

Explanation in fuller detail of the invention will follow in conjunction with and reference to the accompanying drawing wherein the figure is a view partly in elevation and partly in section illustrating one physical embodiment of our concept.

Basically the present invention comprises utilization of a plurality of micro-wave producing units 10, 11, 12 under the general characterization of electron discharge devices, with a novel coupling thereof so as to augment the power output of each by the power output of the others and obtain a resultant greater power output than any one unit would be capable of producing. To appreciate the lack of capability of one unit to

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produce the desired power, the inherent limitations of the structure involved must be understood. As the several units are of the same construction, description of one will suffice for all.

Accordingly, each said unit comprises an evacuated metallic structure providing two hollow-body resonators 13, 14 within which fields, comprising standing electromagnetic waves, are adapted to be set up by the passage of a stream of electrons through restricted parts 15, 16 thereof. The said resonators 13, 14 are so constructed that they have, or may be adjusted to have substantially the same resonant frequency. They are also so constructed that electrons pass completely through the fields of said restricted parts 15, 16 of said resonators, preferably within the period of a half cycle or less of the operating resonant frequency of the resonators. With the electric vector of the electric field of each resonator acting along the line of travel of the electrons and upon the latter for a time preferably equal to one-half cycle or less, successive electrons of the stream will emerge from the restricted part 15 of the initial resonator 13, referred to as the buncher, with variable velocities, and will move through a field-free space 17 separating the restricted parts 15, 16 of the resonators, whereby a concentration of electrons will form around electrons of normal velocity that are preceded by slow electrons and followed by fast electrons. Likewise, diminished numbers of electrons will obtain around electrons of normal velocity that are preceded by fast electrons and followed by slow electrons. Thus, the electrons of the stream pass a given point in waves of increasing and decreasing density, which waves are caused to pass through the restricted part 16 of the second resonator 14, referred to as the catcher, by virtue of which, in conjunction with equality of resonant frequency of the two resonators and proper length of field-free space 17 therebetween, electromagnetic waves are excited in the second resonator or catcher 14 that are stronger than those existing in the initial resonator or buncher 13. With proper coupling of the electromagnetic waves in the catcher with those of the buncher, sustained electromagnetic oscillations will result, such coupling obtaining when the electron groups pass through the restricted portion 16 of the catcher when the field therein is most strongly opposing the motions of the electrons therethrough. An excess of energy is present in the catcher over energy produced in or fed back to the buncher.

The feed-back employed in the primary unit

is by means of a properly positioned cross-connection 18 connecting coaxial wires or rods 19, 20 formed as extensions of loops 21, 22 in the buncher and catcher respectively, said loops having their ends made fast to the walls of the respective resonators in which situated. Furthermore said loops 21, 22 are transverse to the path of the magnetic lines of force within the resonators. The said coaxial wires or rods 19, 20 are concentric within conduits 23, 24 and project externally from said resonators. Appropriate vacuum-tight seals 25, 26 of insulative material, such as glass, are interposed between the wires and rods as usual and as will be understood.

Reverting again to the propagation of the electrons, it may be pointed out that the construction provides a cathode emitter 27 in proximity to and in advance of the first restricted opening or part 15 of the buncher, thereby setting up a copious flow of electrons which pass through the first restricted opening or part 15 where their velocity is modified as a result of which they are bunched as they travel through the field-free space 17, thence through the second restricted part 16 of the catcher where they give up energy for useful purpose, and thence to a collector 23 where remaining energy is dissipated. The passage of the electrons to and from the restricted openings or parts 15, 16 is in each case by way of grids as usual. It must now be apparent from the foregoing, that the smaller the resonators, the smaller those restricted passages become in diameter, and therefore admit smaller power input. As the wave length is directly dependent upon the cross-sectional area of the resonators, it follows that the resonators must be small thereby compelling use of small passages, when designed for micro waves. Thus the resonators are of necessity scaled down more and more for shorter and shorter wave lengths and of necessity the orifice area is proportionately reduced, which in turn reduces the stream current and output of the unit. We have devised means for utilizing a group of units to compound the several outputs thereof into an augmented resultant power output.

Accordingly, in the present disclosure, output from the first unit 10 is by means of a loop 29 from the second resonator or catcher 14, said loop traversing the magnetic field of that resonator and producing wave impulses in a concentric line conduit 30 through which, coaxially thereof, extends a central rod or wire 31 as a continuation of one end of the loop. The other or inner end of that loop is electrically and mechanically attached to the resonator wall. As means of more ready reference to this particular concentric line wave impulse conductor, the same will be referred to generally as the primary connector, it being here called to attention that it constitutes the leg portion of a T-shaped formation of a connector system. The other two units 11, 12 are joined between their buncher resonators with a cross-connector 32 forming the head of the T-shaped formation and accordingly having the primary connector joining therewith at an intermediate point in the length of said cross connector. Within the tubular formation of this cross connector is a central wire or rod 33 which is a continuation of the loops (not shown) in the buncher resonators of units 11, 12 and corresponding to the feed-back loop 21 of the buncher resonator 13 of the first unit.

The wave impulse constituting the output of the first unit is accordingly impressed upon the

input of the other two units and both augments the output thereof and obtains desired oscillation in the buncher resonators thereof without requiring feed-back from the catcher resonators of those units. Full energy transmitted to and developed in the catcher resonators of the units 11, 12 will accordingly be available for output purposes. Output from the said units 11, 12 may be obtained from either or both of the loops in the catcher resonator, and is here shown as applying from both units to a dipole antenna 34 wherein the combined output of all said units is utilized.

In each of the connector parts of the connector system is provided a phase and load time-matching means, that is to say, one such means is provided in the leg portion of that system, another in the branch of cross-connector 32 to the unit 11 and another in the branch of said cross-connector 32 to the other unit 12. As the construction of all of these wave time-matching means is the same, a single description of one will suffice with reference numerals applying to all. The tubular part of the connector is provided with an appropriately situated side opening at an intermediate part of its length. This side opening communicates with the bottom end of a protruding tube 35 preferably of the same diameter as the tubing of the connector system. The outer end of said protruding tube is open and receives the stem portion 36 of a wave-blocking and adjustable tube closure on plug 37 situated within the tube. The stem portion 36 projects from the end of the protruding tube and is there provided with a knurled head 38 for convenient manipulation by the user for adjusting the tube closure or plug to desired position longitudinally within the protruding tube. Axially disposed within the said protruding tube is a wire or rod 39 the inner end of which is secured to the coaxial wire or rod of the connector system. The outer part of this axial rod in the protruding tube is screw threaded and passes through the plug 37 which is correspondingly threaded and thence freely into the stem portion 36. Adjustment of the closure portion may accordingly be obtained by proper rotation of the plug 37 through the agency of knurled head 38.

In operation of the matching means, it appears that waves entering the protruding tube reflect back into the connector system but suffer changes of phase time within the protruding or tuning tube. By appropriate adjustment of the plug 37, the returning wave appears at the front or at the back of the next wave passing through the connector system, which thereby enables the resulting waves in one part of the system to be matched with waves of another part, obtaining desired phase relation. By adjusting the several plugs of the system, the two units 11, 12 fed by unit 10 may be made to operate in phase or to operate in push-pull relation, as may be desired.

Since the various details of construction, as well as the precise relation and functioning of parts are subject to variation and change without departing from the inventive concept or scope of the invention, it is intended that all matter contained in the specification or illustrated in the drawing, shall be interpreted as exemplary and not in a limiting sense. It is also to be understood that the following claim is intended to cover all of the generic and specific features of the invention herein shown and described and all statements of the scope of the invention herein

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set forth as a matter of language which might be said to fall therebetween.

We claim:

In an electron discharge device having hollow-body resonators, the combination of a plurality of units each having a buncher resonator and a catcher resonator, means electrically connecting the catcher resonator of one unit to the buncher resonators of both a second unit and a third unit, said first unit thereby exciting the oscillation of the buncher resonators of said second and third units and augmenting the power output thereof, said second and third units having a pair of concentric line connections of which one joins the inputs of said second and third units and the other joins the outputs thereof, a concentric line

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connection from an intermediate part of said connection joining inputs and connecting with the output of the first unit, said second and third units thereby being in parallel to each other and in series with the first unit, and means for matching phase relations of the power of said units comprising a matching stub extending laterally from the concentric line from the first unit and comprising two other matching stubs extending laterally from the concentric line joining the inputs of the second and third units and on opposite sides of said concentric line from the first unit.

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