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R. I. HARRISON

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SEARCH RECEIVER WITH TRAVELING WAVE TUBE

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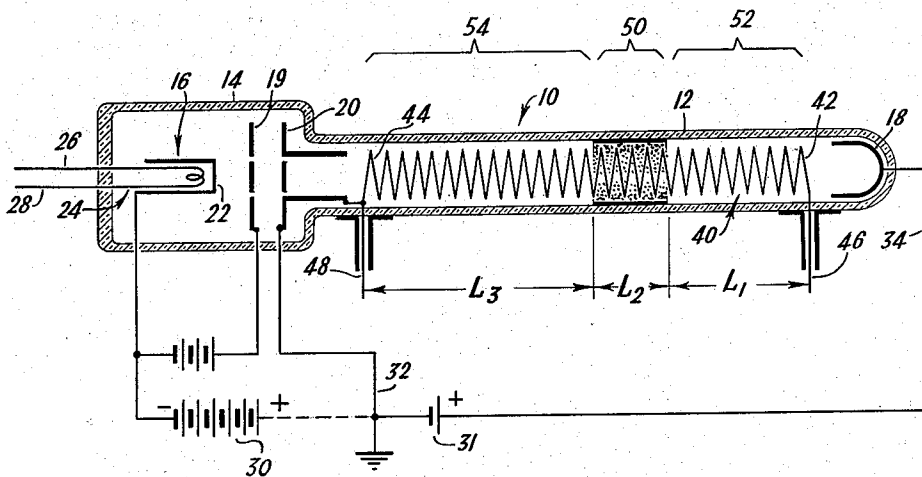


Fig. 1

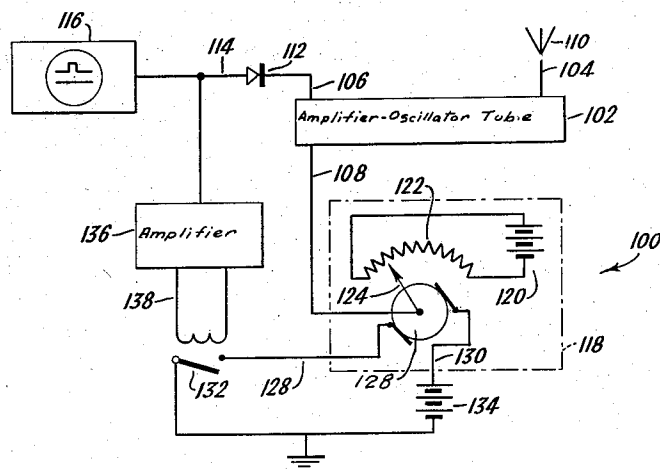


Fig. 2

INVENTOR
RICHARD I. HARRISON

BY *Morton Ameter*
ATTORNEY

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SEARCH RECEIVER WITH TRAVELING WAVE TUBE

Richard I. Harrison, Bronx, N. Y., assignor to Sylvania Electric Products Inc., a corporation of Massachusetts

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The present invention relates to improved traveling wave tube devices, and in particular to a combined backward wave amplifier-oscillator tube and to improved systems incorporating such tubes.

Known traveling wave tubes are electron discharge devices in which a gun assembly produces and accelerates an electron beam along a predetermined path toward a collector electrode upon which the beam terminates. Along the beam path, there is provided a slow wave-guiding or interaction structure, generally in the form of a wire helix, through which the electron beam passes; the wave-guiding structure carries radio frequency energy in substantial juxtaposition to the electron beam for interaction with the electron beam. Appropriate radio frequency input and output connections are provided to the slow wave-guiding structure and the entire traveling wave tube is normally immersed in a uniform axially magnetic field which serves to keep the electron beam from spreading due to space charge effects. In such traveling wave tube devices one or more electrons moving in the electron beam interact with the same effective phase of the moving electric field and energy is transferred between the beam and the field. Many structures are known in the art for utilizing this operating principle to obtain useful results in amplifiers and oscillators.

For example, in forward wave amplifier operation of a traveling wave tube, a radio frequency signal is placed on the helix at the input connection adjacent the electron gun and interaction takes place between the radio frequency field and the electrons in the beam, the interchange in energy favoring an increase in the radio frequency amplitude for a particular beam velocity. The output connection is at the collector end of the tube. Such structures may exhibit an amplitude gain for the radio frequency signal which may be of the order of a thousand times or greater the amplitude of the radio frequency input signal; the voltage at which maximum gain occurs for a given amplifier geometry is known in the art as the synchronous voltage for the tube and the value generally is given in specifying tube operation.

It is known in the art to operate traveling wave tubes as backward wave amplifiers. In such backward wave operation, interaction takes place between the electron beam which travels along a beam path from the electron gun to the collector electrode and the backward wave spatial harmonic whose phase velocity moves in the forward direction and whose energy travels in a direction opposite to the electron beam through the interaction structure. It is characteristic of such backward wave amplifier tubes that the amplification or gain of the tube increases with increases in current flow in the electron beam adjacent to the interaction structure which carries the radio frequency energy; it is further characteristic that the frequency of maximum amplification may be varied by changing the direct current voltage on the interaction structure. As the voltage applied to the interaction structure is varied as a control over the frequency of maximum amplification, the beam current is substantially independent and remains constant despite the voltage variation.

For a given length of interaction structure, there is a

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value of beam current designated as the start oscillation current at which the backward wave tube has an infinite gain; at such start oscillation current the flow of beam current will cause oscillation to occur and the backward wave tube becomes essentially an electronically tuned oscillator. As the length of the interaction structure is increased, the start oscillation current is decreased; and as the length of the interaction structure is decreased the start oscillation is increased. As is understood when the conventional backward wave tube operates as an amplifier the beam current is below the start oscillation current and the gain of the tube increases with beam current up to the point where the start oscillation current is reached and the tube breaks into oscillation. It has been reported that above the start oscillation current, gain is realized at the same frequency as the frequency of oscillation.

Although conventional backward wave tube oscillators have found many applications, there are drawbacks in the practical utilization of such tubes for both amplification and oscillation due to oscillator output at the signal input end of the interaction structure. That is, unwanted oscillator power appears at the radio frequency signal input to the interaction structure, which unwanted power may be the result of imperfect microwave transitions of the tube, improper impedance matching and the like.

It is broadly an object of the present invention to provide a traveling wave tube of the backward wave type which is capable of simultaneous amplification and oscillation. Specifically, it is within the contemplation of the present invention to provide a backward wave amplifier-oscillator tube which may be electronically tuned over a broad frequency band.

It is a further object of the present invention to provide an improved microwave device capable of functioning concurrently as an amplifier and oscillator which makes possible design of a wide variety of microwave transmission systems, particularly those finding military application. To advantage, a combined amplifier-oscillator tube according to the present invention may find application in radar jamming devices, secure transmission radar, search receivers, and other commercial and military systems.

In accordance with an illustrative embodiment demonstrating features of the present invention, there is provided a traveling wave tube which includes means for projecting an electron beam along a predetermined path in one direction, an interaction structure including a foreshortened energy guide for transmitting input signal energy along the beam path in the opposite direction, and a region of concentrated attenuation along the length of interaction structure and intermediate the ends thereof which divides the interaction structure into two lengths coupled together by the region of concentrated attenuation. A signal input connection is provided to the length or region remote from the electron gun while a signal output connection is provided to the length or section contiguous to the electron gun. The section or length having the output connection is longitudinally longer than the section or length having the input connection; accordingly the start oscillation current of the longer section is lower than the start oscillation current of the shorter section. By appropriate selection of the circuit parameters and of the respective lengths of the sections, the tube may be operated at a beam current which is above the start oscillation current for the longer length section and below the start oscillation current for the shorter length section. Therefore, the longer length section operates as an oscillator while the shorter length section simultaneously operates as an amplifier; both of these sections are tuned by the common direct current voltage applied to the interaction structure.

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Although there are many practical applications of the present backward wave amplifier-oscillator tube, there will be detailed hereinafter a search receiver capable of locking onto an unknown radio frequency input signal. Briefly, such search receiver incorporates a backward wave amplifier-oscillator tube of the previously described construction, a detector coupled to the output connection of the tube, means for varying the magnitude of the direct current voltage applied to the interaction structure whereby the common operating frequency of both the oscillator and amplifier sections may be swept over a range of frequencies, and means responsive to output from the detector and controlling variations in direct current voltage such that upon coincidence of the oscillator frequency and the unknown input signal the tube will be locked onto the frequency of the unknown input signal. Such receiver illustrates but one of the many applications of the present combined amplifier-oscillator tube serving in part as an electronically tunable bandpass filter. It will be appreciated that input radio frequencies signals at a frequency other than the frequency of the oscillator section has little or no effect upon the output level; however, as the input signal frequency approaches the frequency of the oscillator section there is a rapid rise of output indicative of coincidence between the frequency of the local oscillator and that of the unknown source.

The above brief description as well as further objects, features and advantages of the present invention will be best appreciated by reference to the following detailed description of a combined backward wave traveling tube amplifier-oscillator tube and an illustrative system according to the present invention when taken in conjunction with the accompanying drawings:

Fig. 1 is a schematic showing of a backward wave oscillator-amplifier tube embodying features of the present invention; and

Fig. 2 is a schematic diagram showing the combined backward wave oscillator-amplifier tube of Fig. 1 embodied in a search receiver.

Referring now specifically to Fig. 1 there is shown an envelope 10 including an elongated slender sleeve 12 and an enlarged bulb end or section 14. Disposed within the bulb end is an electron gun 16 which is arranged to project a beam of electrons along a path axially of the sleeve 12 toward a collector electrode 18. The electron gun, which is well known per se, includes a beam current controlling electrode 19, a focusing and accelerating electrode 20, a cathode 22 capable of emitting electrons and a heater coil 24. Appropriate connections are provided for establishing operating potentials for the several electrodes of the gun assembly 16 and for the collector electrode 18. Specifically, the heater coil 24 is connected by leads 26, 28 to a heater supply (not shown); the focusing and accelerating electrode 20 is connected internally to the interaction structure and both are connected via the lead 32 to the positive side of the voltage source 30; and the collector 18 is connected via lead 34 to an appropriate low voltage source 31 such that unconverted portions of the kinetic energy of the beam appear as heat at the collector electrode 18. The variable voltage source 30 applies direct current voltage between the interaction structure and the cathode.

Disposed within the sleeve 12 is the interaction structure, generally designated by the reference numeral 40, which in this embodiment is illustrated as a continuous wire helix extending between an input connection 42 and an output connector 44. Radio frequency connections are made to the opposite ends of the helix by appropriate input and output wave guide couplings, illustrated as the coaxially coupling 46 connected to the input connection 42 and the coaxial coupling 48 connected to the output connection 44.

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In accordance with the present invention, the interaction structure 40 is divided into three separate sections or lengths by the provision of a region 50 of concentrated attenuation intermediate the ends of the interaction structure and extending for a predetermined length. The region of concentrated attenuation divides the interaction structure into a first section 52 intermediate the radio frequency signal input connections 42, 46 and one end of the region 50 and a second section 54 intermediate the other end of the region 50 and the radio frequency signal output connections 44, 48. The section 54 which is of a length L_3 is longitudinally longer than the section 52 which is of the length L_1 ; thus it follows that the start oscillation current of the section 54 is lower than the start oscillation current of the section 52. Accordingly, it is possible to operate the traveling wave tube at a beam current which is above the start oscillation current for the section 54 and below the start oscillation current for the section 52. It follows that the section 54 operates as an oscillator while the section 52 operates as a backward wave amplifier, both sections 52, 54 being tuned by the common direct voltage applied to the interaction structure 40 which is of the length $L_1 + L_2 + L_3$. The oscillator frequency, as determined by the direct current voltage 30 applied to the interaction structure 40, occurs slightly off the center of the passband for the oscillator section 54; this may be attributed to the fact that section 54 simultaneously operates as an amplifier and oscillator and the center of its amplifier passband exactly coincides with the oscillator frequency. The frequency at which the section 52 amplifies may be varied by varying the voltage applied to the traveling wave interaction structure 40 and is dependent upon the length L_1 of the section 52. Thus the amplifier section 52 operates at a frequency slightly off the frequency of the amplifier-oscillator section 54. However in that the gain of the amplifier-oscillator section 54 is much larger than that of the amplifier section 52 it is possible to design the tube such that maximum gain occurs substantially at the oscillator frequency.

The function of the attenuator section 50 is primarily to define the amplifier section 52 and the oscillator-amplifier section 54. Further the attenuator section 50 determines the amount of coupling between the input and output sections 52, 54 of the backward wave tube. Although some of the radio frequency is lost in the attenuator section the coupling may be made a maximum consistent with the required operational characteristics of the present tube. Further, the concentrated region of attenuation limits the amount of oscillator energy appearing at the input connection 46. As a practical matter it is possible to obtain a nearly ideal match looking into the attenuator 50 from either direction; with a reasonable amount of attenuation any changes in impedance at the input connection negligibly effect the nearly ideal match as seen looking into the attenuator section 50 from the oscillator section 54. Theoretically if the match is perfect there is no microwave field energy from the oscillator at the attenuator. However, as a practical matter imperfect match will occur at the output connection 48. For the small amount of oscillator energy fed back to the attenuator section 50 as a result of this imperfect match, the attenuator assures very little oscillator output at the input connections 42, 46. Thus, it is possible to minimize the oscillator field energy that can get to the radio frequency input. Still further both the oscillator section 54 and the amplifier section 52 produce amplification and the attenuator section 50 in this respect functions much in the same way as a forward broad band amplifier to prevent oscillation resulting from feedback along the helix from output to input due to mismatch at the output and input connections. It will be appreciated that two factors contribute to isolation of the oscillator section 54 from the input section, name-

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ly, good matching of the attenuator and the value of the attenuator. As to coupling signal power from input to output it is desirable to have the attenuator value or length as small as possible consistent with the requirements of isolation of the oscillation output from the radio frequency input.

Details of experiments conducted with a backward wave oscillator-amplifier tube according to the present invention may further contribute to a thorough understanding of the present invention. In an experimental tube the interaction structure was a molybdenum tape helix nine inches in length, that is $L1+L2+L3$ was equal to nine inches. The tape size was .020 inch by .075 inch in cross section and was wound with a pitch of nine turns per inch. The outer diameter of the helix was .420 inch and the inner diameter was .380 inch. The helix was contained in a precision bore glass tube axially straight and of Corning 7052 glass whose inner diameter was .420 inch and whose outer diameter was .500 inch. The electron gun was a hollow beam type capable of delivering about twelve milliamperes. The hollow beam had an outer diameter of .357 inch and inner diameter of .307 inch and was directed toward a cup shaped collector. The electron gun was of the immersion type and thus the entire tube including the gun assembly was disposed within a longitudinal magnetic field to keep the beam collimated. The attenuator section 50 was formed by placing an aquadag coating external to the glass while each end of the helix was terminated in an appropriate broad band transistion to standard coaxial lines.

The experiments performed with the aforesaid tube were intended to illustrate operating principles rather than to indicate range or order of magnitude of electrical characteristics. The tube under test was actually converted from a conventional backward wave oscillator capable of delivering from between eleven to a hundred milliwatts output and hence data cannot be used to predict operation of low-level units, such microwave receivers. Gain tests conducted with the start oscillation current below value for oscillation of section 54 indicate that the tube under these conditions performs very much the same way as a conventional backward wave amplifier. As in a conventional backward wave amplifier, the closer the beam current is made to the start oscillation value, the higher the backward wave gain. Operation as a backward wave oscillator-amplifier in accordance with the present invention resulted in tube output with the input pulses appearing as amplitude modulation of the carrier frequency of three thousand megacycles per second. This amplitude modulation can be made positive or negative by shifting the phase of the input signal and finds application where it is desirable to invert the modulation of the input signal. Actual gain values could be obtained by detecting the signal output and comparing the detected output with the signal input. Recalling that the backward wave oscillator-amplifier tube of the present invention is electronically tunable by varying the direct current voltage on the interaction structure, it is evident that there is always an oscillator output at a frequency corresponding to the voltage applied to the interaction structure. Only when the oscillator output frequency coincides with the carrier frequency of the pulse signal input is maximum gain attained; thus the tube will have maximum gain at the same frequency as the frequency of oscillation of the section 54.

In summary the following conclusions may be drawn with respect to the conducted experiments:

As to the relationship between gain and beam current, it was indicated that the gain increased as the beam current approached the start oscillation current whether the beam current was above or below the start oscillation current. Below the start oscillation current the tube behaved as backward amplifier; while above start

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oscillation current the tube operated as a backward wave amplifier-oscillator, amplifying and oscillating simultaneously at the same frequency.

As to the relationship between gain and helix voltage response curves indicate typical tuned amplifier operation with maximum gain occurring when the carrier frequency of the input impulses coincided with the backward wave amplifier-oscillator frequency as controlled by the voltage applied to the interaction structure.

As to the acceptance band which is a measure of the oscillation frequency band for three db gain variation from maximum gain for a given input signal frequency, it was found that the acceptance band was approximately 1 to 5 megacycles wide depending upon beam current and the position of the attenuating section 50.

As to band width which is a measure of the input signal frequency band for a three db gain variation from maximum gain for a given helix voltage, the results show that the band width was of the order of 1 to 5 megacycles wide depending upon beam current and attenuator position.

Reference will now be made to Fig. 2 wherein there is shown a search receiver embodying a combined traveling wave tube oscillator-amplifier tube according to the present invention which is capable of identifying and storing the carrier frequency of the unknown radio frequency input signal. The receiver, generally designated by reference numeral 100 includes a backward amplifier-oscillator tube 102 as detailed in conjunction with Fig. 1 which includes a signal input connection 104, a signal output connection 106 and a connection 108 to the interaction structure of the tube for varying the direct current voltage applied to the interaction structure as a means for controlling the common operating frequencies of the amplifier and oscillator sections of the tube 102. Connected to the input connection 104 is an antenna 110 which applies the unknown radio frequency input signal to the input end of the interaction structure for backward wave interaction. The output connection 106 is connected to a detector 112, which may be in the form of a crystal diode. The detected output appearing on line 114 may be visually displayed on an appropriate oscilloscope such as illustrated at 116; further the detected output is used to control the sweeping of the oscillator frequency of the tube 102 as determined by the variable direct current voltage applied on lead 108. The variations in direct current voltage on the lead 108 are attained in the illustrative device through the provision of appropriate sweep supply 118 illustrated as including a source of direct current voltage 120 connected in circuit with a resistance 122 which is tapped by a rotating contact 124 connected to lead 108. The contact 124 is moved along the resistance 122 by a motor 126 having energization connections 128, 130. The energization circuit for the motor includes a normally closed switch 132 and a voltage source 134. The helix sweep supply 118 is arranged to vary the voltage on the lead 108 continuously or as long as the switch 132 remains closed and; when the switch 132 is opened the direct current voltage is of a magnitude determined by position of the contactor 124 in relation to the resistor 122. For this purpose, the output 114 of the detector is applied to an amplifier 136 which has a relay 138 connected in its output circuit in controlling relation to the switch 132. Upon output of the detector 112 corresponding to coincidence between the unknown input frequency and the frequency generated by the combined amplifier-oscillator tube 102, the amplifier 136 and relay 138 are effected to open the switch 132 thus interrupting the voltage sweep for the interaction structure and continuing operation of the backward wave amplifier-oscillator tube 102 at the unknown frequency. Appropriate identification friend or foe equipment and/or radar jamming devices may be associated with the search receiver as is well understood in the art.

As previously stressed other applications of the combined backward wave amplifier-oscillator tube of the present invention are contemplated. For example, the present tube finds numerous applications in conjunction with combined traveling wave tube indicators of the type disclosed and described in co-pending application Serial Number 275,539 in the name of Phillipe Clavier and assigned to the assignee of the present invention. For example, general purpose radar receivers may be greatly simplified by incorporating a traveling wave tube amplifier and indicator according to the mentioned co-pending application and the backward wave traveling wave tube of the present invention. Not only is the radar receiver configuration considerably simplified but further the functions of several mixers and local oscillators are combined effecting substantial reductions in the number of tubes and associated circuits.

I claim:

1. A traveling wave tube comprising means for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure including input and output connections and a foreshortened energy guide for transmitting input signal energy along said beam path in the opposite direction, and a region of concentrated attenuation along the length of said interaction structure intermediate said input and output connections dividing said interaction structure into two sections coupled together, the section adjacent said output connection being of a length greater than the other of said sections.

2. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, guide means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said guide means dividing said guide into two parts coupled together by said attenuating means, the part adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator-amplifier section, the part adjacent said collector electrode being shorter than said first named part and serving with the coextensive part of said tube to provide a backward wave amplifier section.

3. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, a helix adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said helix dividing said helix into two parts coupled together by said attenuating means, the part adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator-amplifier section, the part adjacent said collector electrode being shorter than said first named part and serving with the coextensive part of said tube to provide a backward wave amplifier section.

4. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, guide means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said guide means dividing said guide means into two parts coupled together by said attenuating means, the part adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator-amplifier section, the part adjacent said collector electrode being shorter than said first named part and serving with the coextensive part of said tube to provide a backward wave amplifier section, means for establishing the beam current of said tube at a value above the start oscillation current for said oscillator-amplifier section and below the start oscillation current for said amplifier section,

and means for applying a varying direct current voltage to said guide means whereby the common operating frequency of said sections may be varied over a range.

5. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, guide means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said guide means dividing said guide means into two parts coupled together by said attenuating means, the part of said guide means adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator-amplifier section, the part of said guide means adjacent said collector electrode being shorter than said first named part and serving with the coextensive part of said tube to provide a backward wave amplifier section, means for applying signal input of unknown frequency to said amplifier section, a detector circuit deriving input from said amplifier-oscillator section, means for tuning said amplifier-oscillator section through a frequency range including said unknown frequency, and means controlled from the output of said detector for interrupting tuning of said amplifier-oscillator section when the latter is operating at a frequency substantially equal to said unknown frequency.

6. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, a continuous helix adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said helix dividing said helix into two lengths coupled together by said attenuating means, the length adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator section, the length adjacent said collector electrode being shorter than said first named length and serving with the coextensive part of said tube to provide a backward wave amplifier section, means for applying signal input of unknown frequency to said amplifier section, a detector circuit deriving input from said oscillator section, means for tuning said oscillator section through a frequency range including said unknown frequency, and means controlled from the output of said detector for interrupting tuning of said oscillator section when the latter is operating a frequency substantially equal to said unknown frequency.

7. A traveling wave tube device comprising means for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure including a foreshortened energy guide for transmitting input signal energy along said beam path in the opposite direction, a region of concentrated attenuation along the length of said interaction structure and intermediate the ends thereof dividing said interaction structure into an amplifier section and an oscillator section, a signal input connection to said amplifier section, a signal output connection from said oscillator section, means for sweeping the operating frequency of said sections through a range of frequency values, detector means receiving signal output from said oscillator section, said detector providing a control signal when the operating frequency corresponds substantially to the frequency of the signal input to said amplifier section, and means responsive to said control signal for interrupting the frequency sweep of said sections.

8. A traveling wave tube device comprising means for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure including a helix for transmitting input signal energy along said beam path in the opposite direction, a region of concentrated attenuation along the length of said helix and intermediate the ends thereof dividing said helix into a first length serving in an amplifier section and a second length serving in an oscillator section, a signal input con-

nection to said amplifier section, a signal output connection from said oscillator section, means for sweeping the operating frequency of said sections through a range of frequency values, detector means receiving signal output from said oscillator section, said detector providing a control signal when the operating frequency corresponds substantially to the frequency of the signal input to said amplifier section, and means responsive to said control signal for interrupting the frequency sweep of said sections.

9. A search receiver capable of identifying and storing an unknown input signal comprising a backward wave amplifier-oscillator tube including an electron gun and a collector electrode defining a beam path therebetween, an interacting structure including transmission means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode toward said gun, input means including an antenna coupled to said transmission means adjacent said collector electrode for applying said input signal to said transmission means and output means coupled to said transmission means adjacent said gun for removing said electromagnetic wave therefrom, a detector deriving its input from said output means, attenuating means along said beam path intermediate said input and output means and dividing said interaction structure into an amplifier section intermediate said input means and one end of said attenuating means and into an oscillator section intermediate the other end of said attenuating means and said output means, said oscillator section being longer in length than said amplifier section, said tube being operated at a beam current below the start oscillation current for said amplifier section and above the start oscillation current for said oscillator section, means for applying varying direct current voltage to said transmission means, the instantaneous magnitude of said voltage determining the common operating frequency of said sections, means for varying the magnitude of said direct current voltage whereby the common operating frequency may be swept over a range of frequencies, and means responsive to the output from said detector and controlling the means for varying said direct current voltage.

10. A backward wave amplifier-oscillator tube comprising means providing an electron beam in a forward direction along a beam path, an interaction structure adjacent to and along said beam path for propagating an electromagnetic wave in a backward direction along said beam path, input means coupled to said interaction structure for applying an electromagnetic wave to said interaction structure for propagation in the backward direction, output means coupled to said interaction structure for removing said electromagnetic wave therefrom, attenuating means along said interaction structure intermediate said input and output means dividing said interaction structure into a first section capable of operation as a backward wave oscillator-amplifier and a second section capable of operation as a backward wave amplifier, and means for operating said tube at a beam current above the start oscillation current for said first section and below the start oscillation current for said second section.

11. A traveling wave tube comprising means including an electron gun for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure including a foreshortened energy guide for transmitting input signal energy along said beam path in the opposite direction, attenuating means along the length of said interaction structure and intermediate the ends thereof dividing said interaction structure into two sections coupled together in an amount determined by the magnitude of said attenuation, one of said sections being adjacent said electron gun and of a length greater than the other of said sections, means for applying a signal input to the other of said sections and for extracting signal output from said one section, and means for establishing a beam current above the start oscillation

current for said one section and below the start oscillation current for said other section.

12. A traveling wave tube device comprising means for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure for transmitting input signal energy along said beam path in the opposite direction, attenuating means along the length of said interaction structure and intermediate the ends thereof dividing said interaction structure into an amplifier section and an oscillator section, a signal input connection to said amplifier section, a signal output connection from said oscillator section, means for sweeping the operating frequency of said sections through a range of frequency values, means receiving signal output from said oscillator section and providing a control signal when the operating frequency corresponds substantially to the frequency of the signal input to said amplifier section, and means responsive to said control signal for interrupting the frequency sweep of said sections.

13. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, guide means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, attenuating means along an intermediate portion of said guide means dividing said guide means into two parts coupled together by said attenuating means, the part of said guide means adjacent said electron gun serving with the coextensive part of said tube to provide a backward wave oscillator section, the part of said guide means adjacent said collector electrode being shorter than said first named part and serving with the coextensive part of said tube to provide a backward wave amplifier section, means for applying signal input of unknown frequency to said amplifier section, a traveling wave tube indicator deriving input from said amplifier-oscillator section, and means for tuning said amplifier-oscillator section through a frequency range including said unknown frequency.

14. In combination with a tube including an electron gun and a collector electrode defining an electron beam path, guide means adjacent to and along said beam path for propagating an input signal along said beam path in the direction from said collector electrode to said gun, means along an intermediate portion of said guide means establishing within said tube a backward wave oscillator section and a backward wave amplifier section, means for applying signal input of unknown frequency to said amplifier section, a traveling wave tube indicator deriving input from said amplifier-oscillator section, and means for tuning said amplifier-oscillator section through a frequency range including said unknown frequency.

15. A traveling wave tube device comprising means for projecting an electron beam along a predetermined beam path and in one direction, an interaction structure for transmitting input signal energy along said beam path in the opposite direction, attenuating means along the length of said interaction structure and intermediate the ends thereof dividing said interaction structure into an amplifier section and an oscillator section, a signal input connection to said amplifier section, a signal output connection from said oscillator section, means for sweeping the operating frequency of said sections through a range of frequency values, and means receiving signal output from said oscillator section and providing a control signal when the operating frequency corresponds substantially to the frequency of the signal input to said amplifier section.

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