United States Patent [19]

Chalmers

[11] **3,786,301**

[45] **Jan. 15, 1974**

[54] **TRAVELLING WAVE TUBES**

[75] Inventor: **Peter Michael Chalmers,** Essex, England

[73] Assignee: **English Electric Valve Company Limited,** Chelmsford, Essex, England

[22] Filed: **Nov. 9, 1972**

[21] Appl. No.: **304,992**

[30] **Foreign Application Priority Data**

Nov. 9, 1971 Great Britain 51,907/71

[52] **U.S. Cl.** **315/3.6,** 315/39.3, 332/58

[51] **Int. Cl.** **H01j 25/34**

[58] **Field of Search** 315/3.6, 39.3; 332/58

[56] **References Cited**

UNITED STATES PATENTS

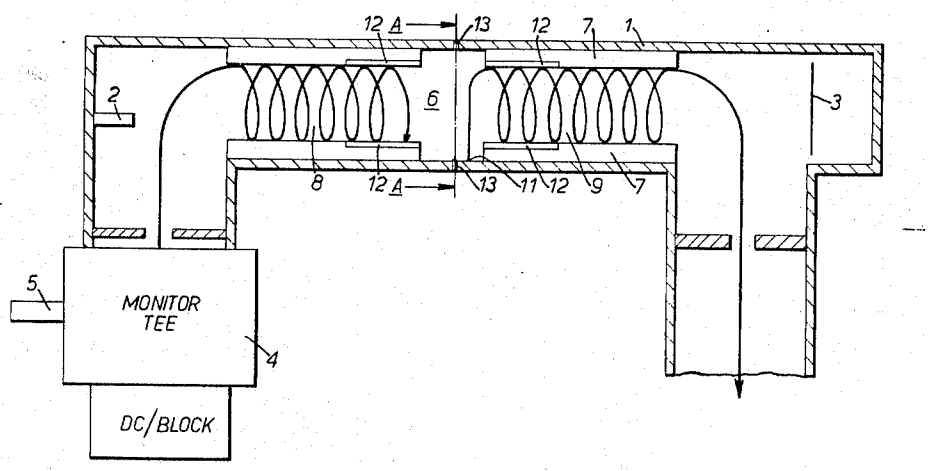
2,899,596	8/1959	Johnson	315/3.6
2,891,191	6/1959	Heffner et al.	332/58 X
2,999,182	9/1961	Field	315/3.6
3,024,384	3/1962	Itzkan et al.	315/3.6
3,050,657	8/1962	Branch, Jr.	315/3.6
3,028,597	4/1962	Cicchetti et al.	315/3.6
3,366,885	1/1968	White et al.	315/3.6

Primary Examiner—James W. Lawrence
Assistant Examiner—Saxfield Chatmon, Jr.
Attorney—Baldwin, Wight & Brown

[57] **ABSTRACT**

A phase modulated travelling wave tube in which amplitude modulation of the signal passing through the tube is reduced by providing a wave retarding structure which is in two electrically isolated portions arranged co-axially in line with one another, and applying modulating d.c. potential to the portion of the wave retarding structure nearer the electron gun.

13 Claims, 2 Drawing Figures



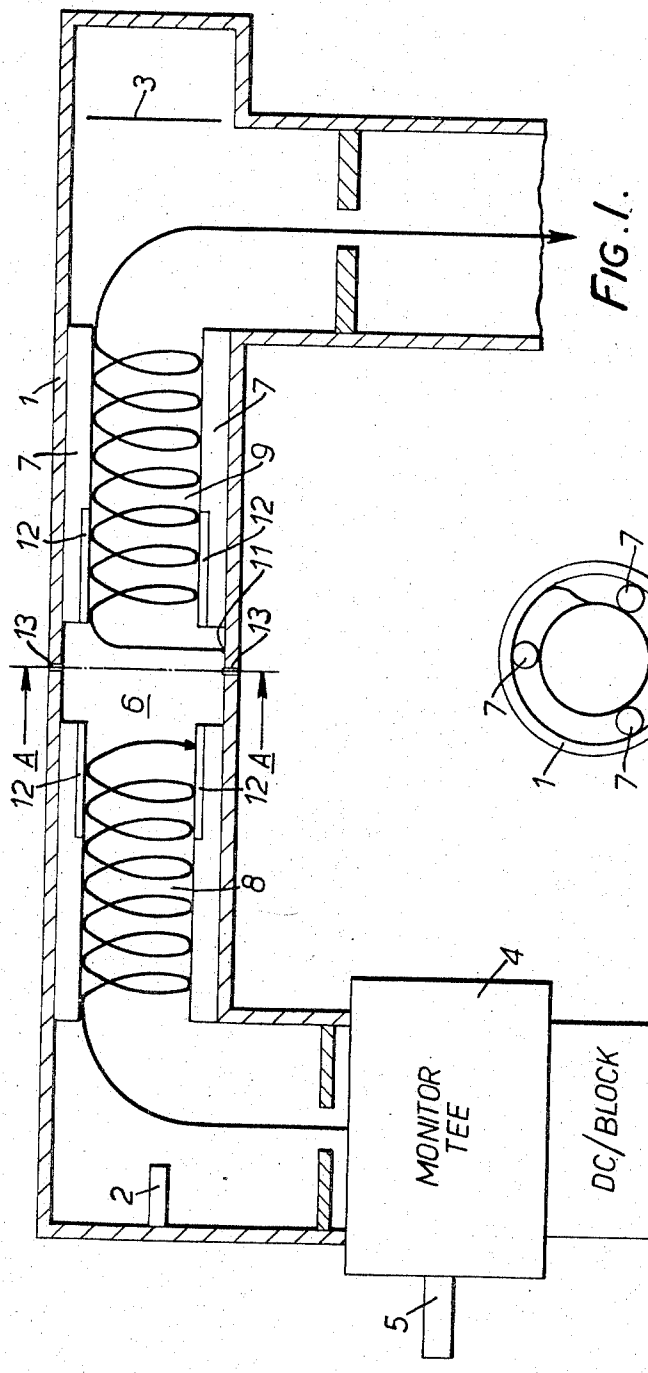


FIG. 1.

FIG. 2.

TRAVELLING WAVE TUBES

This invention relates to travelling wave tubes, and more particularly to forward travelling wave amplifier tubes. Forward travelling wave tubes rely for an amplifying effect on the transfer of energy from a stream of electrons generated by an electron gun to the electromagnetic field of an impressed signal. As at present known the required inter-action between the stream of electrons and the impressed signal is achieved by providing a wave retarding structure consisting of a linearly arranged succession of electrically resonant cells having unity coupling factor each to its neighbour through which the beam from the electron gun is directed co-axially, there being provided means for coupling an input signal to the line of cells at the gun end thereof and means for taking off an output signal at the other end of said line of cells. The succession of cells is designed to retard the passage of an RF input wave applied to the input means to such an extent that its velocity down the line of cells at least approximately matches the velocity of the electrons in the beam from the gun. Electrons bunch modulated by the wave near the input means are further bunch modulated successively along the line of circuits. Most commonly the line of circuits takes the form of a helical coil of wire. Each turn of the helix possessing the necessary capacitance and inductance to conduct the RF wave from turn to turn.

The electrons from the gun are maintained and controlled in their velocity by the application of suitable voltage between the helix and the gun cathode. By varying this last mentioned voltage, phase modulation of the signal passing through the tube may be accomplished. This, however, not only phase modulates the signal passing through the tube but varies the degree of bunch modulation and so results in amplitude modulation of the signal passing through the tube. In many cases this amplitude modulation is objectionable.

The present invention seeks to provide improved forward travelling wave tubes in which the aforementioned disadvantage is at least reduced.

According to this invention a forward travelling wave tube is provided in which the wave retarding structure is provided in two electrically isolated portions coaxially in line with one another, means being provided for applying modulating d.c. potential to the portion of the wave retarding structure nearer the gun.

In the present preferred embodiment of the invention the other portion of said wave retarding structure is connected to earth conductively or capacitively at its end nearer the gun.

Normally in this case the output end of said other portion of said wave retarding structure is connected directly to a load circuit.

In another embodiment of the invention the other portion of said wave retarding structure is connected to a d.c. insulated output coupling circuit and means are provided for applying a d.c. bias voltage directly to the said second portion whereby the velocity of the electrons in the beam is sustained to maintain approximate equality between the velocity of electrons in the beam and the velocity of the radio frequency wave down the wave retarding structure.

The one and other portions of the wave retarding structure may or may not be equal in functional length and an optimum ratio exists which depends upon the

accelerating voltage at the electron gun, the velocity maintaining voltage on the one portions, the required signal gain ratio and the maximum permitted degree of amplitude modulation.

In accordance with known structures it is necessary in some cases to incorporate attenuating means within the field of the wave retarding structure to suppress internal reflections of the radio frequency wave in order to achieve stability of operation.

In accordance with known practice such attenuating means may consist of resistive coatings over part of the lengths of rods supporting the helix. The attenuating means may be provided at the output end of the one portion of the wave retarding structure or at the output end of the one portion and/or the input end of the second portion.

The invention is illustrated in and further described with reference to the accompanying drawing in which,

FIG. 1 is a highly schematic diagram of one form of forward travelling wave tube in accordance with the present invention and

FIG. 2 is a cross-section taken along the line AA.

Referring to the drawing, the tube consists of an envelope **1** of metal within which is a cathode ray gun **2** and a collector electrode represented by **3**. At the gun end of the tube is provided a so-called "monitor tee" **4** having an input **5** to which modulating voltage may be applied. Between the gun **2** and the collector **3** is a wave retarding structure **6** consisting of helical turns of wire. The helical turns are supported by insulating support rods **7**. As so far described the tube is as known per se.

In accordance with the present invention, however, the wave retarding structure **6** is divided into two portions **8** and **9**. The one portion **8** near the gun **2** is connected to the "monitor tee" **4** to receive modulating potential therefrom at its end near the gun **2**. The other end of the wave retarding structure **8** is isolated from frame earth, i.e., isolated from the metal envelope **1**. The end of the other portion **9** of the wave retarding structure **6** is connected at **11** to frame earth, whilst its end adjacent to the collector **3** provides a direct output for connection to a load. In order to suppress internal reflections of the RF wave in accordance with known practice, attenuating material **12** is provided on the support rods **7** over a portion of the length of the wave retarding structure **6**. In this example the attenuating material **12** is provided both at the output end of the one portion **8** and the input end of the other portion **9** of the wave retarding structure **6**.

For convenience in construction the complete tube is made up in two sections; the one to the left of the line AA being united by welding represented by **13** to the other section to the right of the line AA as a final step in the manufacture of the travelling wave tube.

I claim:

1. A forward travelling wave tube comprising, in combination:

an evacuated envelope;

an electron gun in said envelope and a collector electrode in said envelope spaced from said electron gun and between which a beam of electrons is produced in accord with an applied signal; and

wave retarding means in said envelope disposed between said electron gun and said collector electrode for phase modulating said applied signal and amplifying the phase modulated signal without sig-

nificant amplification of the applied signal, said wave retarding means comprising a first helical wave retarding portion extending axially between said electron gun and said collector electrode and a second helical wave retarding portion coaxial of the first portion and extending between it and said collector electrode, means for applying a modulating d.c. potential to said first helical portion, output terminal means connected to said second helical portion, and said first and second helical portions being electrically isolated from each other whereby respectively to phase modulate the applied signal and to amplify the phase modulated signal without significant amplitude modulation of the applied signal.

2. The forward travelling wave tube as defined in claim **1** wherein said first and second helical portions have substantially similar pitch and diameter.

3. The forward travelling wave tube as defined in claim **2** wherein said means for modulating is connected to that end of said first helical portion nearest said electron gun and said output terminal means is at that end of said second helical portion nearest said collector electrode.

4. The forward travelling wave tube as defined in claim **1** wherein said means for modulating is connected to that end of said first helical portion nearest said electron gun and said output terminal means is at that end of said second helical portion nearest said collector electrode.

5. A tube as claimed in claim **4** and wherein said second helical portion is connected to earth conductively or capacitively at its end nearer the gun.

6. A tube as claimed in claim **2** and wherein means are provided for applying a d.c. bias voltage directly to the said second helical portion whereby the velocity of the electrons in the beam is sustained to maintain approximate equality between the velocity of electrons in the beam and the velocity of the radio frequency wave down the wave retarding structure.

7. A tube as claimed in claim **3** and wherein means are provided for applying a d.c. bias voltage directly to the said second helical portion whereby the velocity of the electrons in the beam is sustained to maintain approximate equality between the velocity of electrons in the beam and the velocity of the radio frequency wave down the wave retarding structure.

8. A tube as claimed in claim **4** and wherein means are provided for applying a d.c. bias voltage directly to the said second helical portion whereby the velocity of the electrons in the beam is sustained to maintain approximate equality between the velocity of electrons in the beam and the velocity of the radio frequency wave down the wave retarding structure.

9. A tube as claimed in claim **1** and wherein the means are provided for applying a d.c. bias voltage directly to the said second helical portion whereby the velocity of the electrons in the beam is sustained to maintain approximate equality between the velocity of electrons in the beam and the velocity of the radio frequency wave down the wave retarding structure.

10. A tube as claimed in claim **1** and where attenuating means is incorporated within the field of the wave retarding structure to suppress internal reflections of the radio frequency wave in order to achieve stability of operation.

11. A tube as claimed in claim **10** and wherein said attenuating means may consist of resistive coatings over part of the lengths of rods supporting the helix.

12. A tube as claimed in claim **10** and wherein attenuating means is provided at the output end of the one portion of the wave retarding structure.

13. A tube as claimed in claim **10,** and wherein attenuating means is provided in the input end of said second portion.

* * * * *