Aug. 31, 1954 J. BERNIER 2,688,106

TRAVELING WAVE AMPLIFYING TUBE WITH A MAGNETIC FIELD

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Fig:1

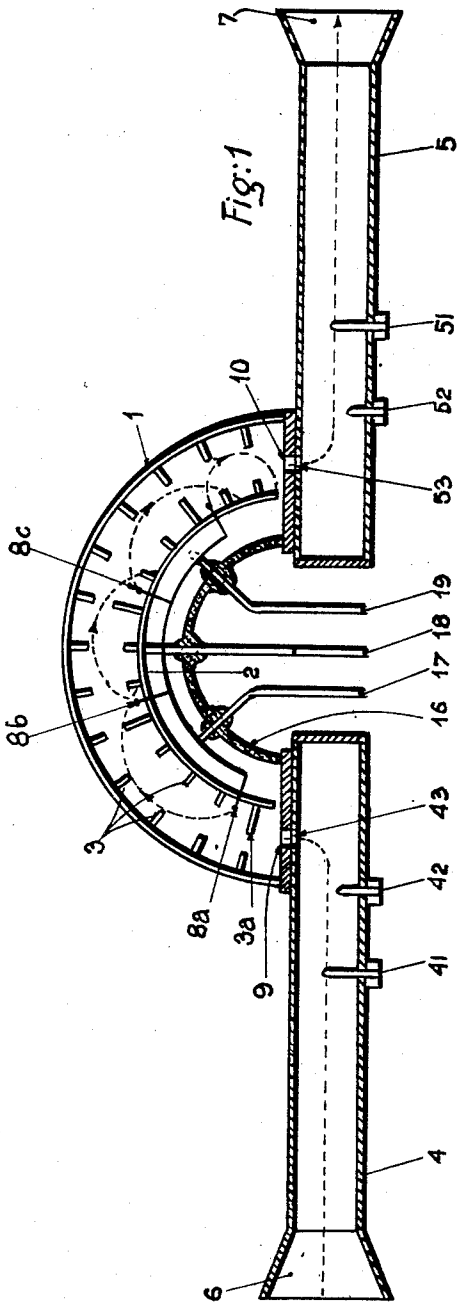
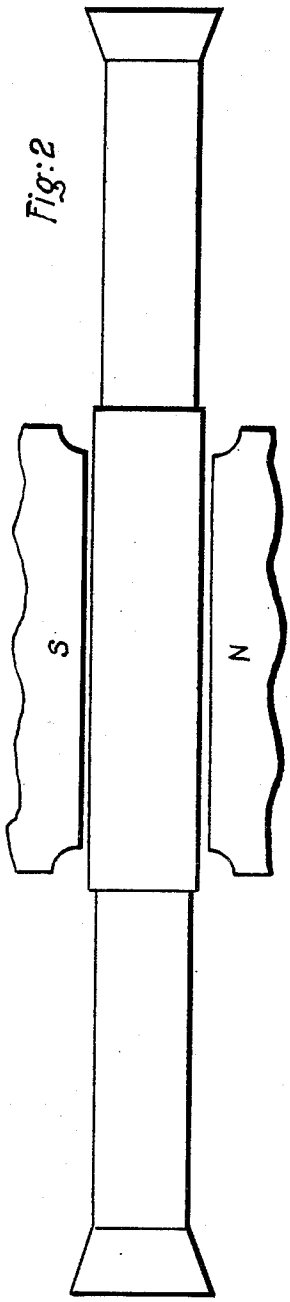


Fig:2



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TRAVELING WAVE AMPLIFYING TUBE WITH A MAGNETIC FIELD

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6 Claims. (Cl. 315—3)

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In co-pending patent application Ser. No. 794,164 filed on December 27, 1947, in the names of O. Doehler, H. Huber and W. Kleen, now Patent No. 2,511,407, a tube is described in which an electron beam is made to interact with a travelling wave propagated between the conductors of a delay line curved in the shape of a circle and located in a magnetic field at right angles to the plane of the circle.

In said patent application, mention is also made of the difficulties which are encountered when it is desired to prevent the output of the tube from reacting on its input, and I have found that in spite of the separating partition provided in the aforesaid application, this reaction cannot be completely eliminated in the circular embodiment considered therein.

My invention is intended to eliminate this drawback by providing the tube with improvements which will be described hereinafter.

According to the invention, the delay line extends over only a portion of the circumference of a circle and is preferably of semi-circular shape with a definitely separated input and output end.

The invention also covers the combination of the shape in question with the construction of the line in the shape of two conductors, at least one of which is provided with fins arranged as baffles, and also the injection into the line of a plurality of beams which are produced by a plurality of cathodes and which begin successively to act on the wave when the amplification of the wave produced by the previous beam ceases to increase sufficiently.

The invention will be more clearly understood by considering Figs. 1 and 2 of the accompanying drawing, which show by way of a non-limitative example a particularly advantageous structure from a constructional standpoint, respectively in longitudinal section and in perpendicular projection.

In Fig. 1, 4 and 5 are respectively the input and output guides provided with their horns 6 and 7 and with adapting devices 41, 42, 51, 52. Said guides are provided with openings 43 and 53 for enabling the guides to be coupled to a semi-cylindrical travelling or progressive-wave tube. Said tube is provided with a plurality of cathodes 8*a*, 8*b*, etc., supplying a beam which travels in the interaction duct defined between the electrodes 1 and 2. The outer portion 1 of the guide, of low phase velocity, forms one of the walls of the vacuum chamber and is raised to the same potential as the input and output wave-guides, while the inner portion 2 and also the cathodes 8*a*, 8*b*, etc.,

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are raised to a negative potential with respect to 1. The conductors 1 and 2 of the delay line are provided with fins 3 arranged as baffles. At 3*a* specially dimensioned fins are shown for matching the wave-propagation circuit despite the discontinuities introduced by the cathodes. The vacuum chamber is completed by a glass wall 16 and also by glass plugs 9 and 10 adapted to obstruct the openings 43 and 53, while the passages 17, 18, 19 through the wall 16 enable the cathodes and the electrode 2 to be supplied. The cross-section of the travelling-wave tube is rectangular and the magnetic field is applied between two flat pole-pieces N S which are shown in Fig. 2 and surround the flanks of the tube.

What I claim is:

1. An electronic amplifier comprising means for establishing a substantially time-constant magnetic field, an electron and wave interaction duct located within said field and extending in a plane substantially perpendicular to the lines of force thereof, and at least one emissive cathode having its surface substantially parallel to said lines of force, the electron flow emitted by said cathode being located in the said duct and within said field, and the combination which comprises two conductors curved in the shape of concentric circular arcs substantially shorter than a full circumference and having their surfaces parallel to the lines of force of the magnetic field, said conductors bounding said interaction duct, terminal connections to the conductors thereby to produce therebetween an electrical potential giving rise to a substantially time-constant electrostatic field substantially perpendicular to the said time-constant magnetic field, at least one of the conductors including elements forming an electrical delay line, thereby to produce a radio-frequency field having an electrical component perpendicular to the crossed substantially time-constant electrostatic and magnetic fields, said elements having the characteristics of longitudinal inductances inserted in a Lecher line and being so dimensioned that the phase propagation velocity of the radio-frequency field along the delay line is less than in space and substantially equal to the velocity of electrons in the duct, the said conductors having radio-frequency input and output extremities separated from each other, the said extremities being provided with means for coupling to outside circuits for exciting an electromagnetic wave in the radio frequency input terminal and for collecting amplified energy at the radio frequency output terminal, and an envelope which is a portion of a hollow toroid

containing said conductors and cathodes and extending substantially over the length of said arcs occupied by said curved conductors.

2. An amplifier according to claim 1, wherein the circular arcs of the conductors of the delay line are of substantially 180°.

3. An amplifier according to claim 1, wherein one of said conductors forms a portion of the envelope of the container, said envelope being completed by a wall located on the opposite side of the second of said conductors with respect to the said envelope-forming conductor and provided with passages through an insulator, for supplying the second said conductor and at least one emitting cathode.

4. An electronic amplifier comprising means for establishing a substantially time-constant magnetic field, an electron and wave interaction duct located within said field and extending in a plane substantially perpendicular to the lines of force thereof, and at least one emissive cathode having its surface substantially parallel to said lines of force, the electron flow emitted by said cathode being located in the said duct and within said field, and the combination which comprises two conductors curved in the shape of concentric circular arcs substantially shorter than a full circumference and having their surfaces parallel to the lines of force of the magnetic field, said conductors bounding said interaction duct, the interior conductor being in the form of a circularly bent metallic sheet, terminal connections to the conductors thereby to produce therebetween an electrical potential giving rise to a substantially time-constant electrostatic field substantially perpendicular to the said time-constant magnetic field, at least one of the conductors including elements forming an electrical delay line, thereby to produce a radio-frequency field having an electrical component perpendicular to the crossed substantially time-constant electrostatic and magnetic fields, said elements having the characteristics of longitudinal inductances inserted in a Lecher line and being so dimensioned that the phase propagation velocity of the radio-frequency field along the delay line is less than in space and substantially equal to the velocity of electrons in the duct, the said conductors having radio-frequency input and output extremities separated from each other, the said extremities being provided with means for coupling to outside circuits for exciting an electromagnetic wave in the radio-frequency input terminal and for collecting amplified energy at the radio frequency output terminal.

5. An amplifier according to claim 2, comprising waveguides mounted in alignment and coupled to the input and the output of the delay line for exciting and collecting the electromagnetic wave.

6. An electronic tube comprising means for establishing a substantially time-constant magnetic field, an electron and wave interaction duct located within said field and extending in a plane substantially perpendicular to the lines of force thereof, two substantially parallel conductors curved in the shape of concentric circular arcs substantially shorter than a full circumference and having their surfaces parallel to the lines of force of the magnetic field, said conductors bounding said interaction duct, terminal connections to the conductors thereby to produce therebetween an electrical potential giving rise to a substantially time-constant electrostatic field substantially perpendicular to the said time-constant magnetic field, at least one of said conductors including elements forming an electrical delay line, thereby to produce a radio-frequency field having an electrical component perpendicular to the crossed substantially time-constant electrostatic and magnetic fields, a plurality of emissive cathodes adjacent one of said conductors and distributed along said delay line, the surfaces of said cathodes being substantially parallel to the lines of force of said magnetic field and the electron flow emitted therefrom being located in the said duct and within said crossed fields, said delay line elements having the characteristics of longitudinal inductances inserted in a Lecher line and being so dimensioned that the phase propagation velocity of the radio-frequency field along the delay line is less than in free space and substantially equal to the velocity of electrons emitted by said cathodes in the duct, the said conductors having radio-frequency input and output extremities separated from each other, and means for coupling at least one of said extremities to an outside radio-frequency circuit.

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