Jan. 23, 1940. K. FRITZ 2,187,775

PUSH-PULL TUBE ARRANGEMENT

Filed Nov. 26, 1937

Fig. 1

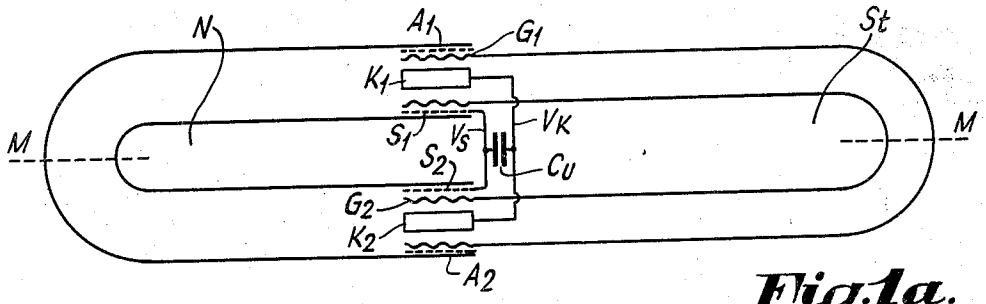
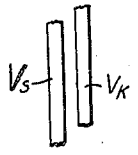


Fig.1a.

Fig. 2



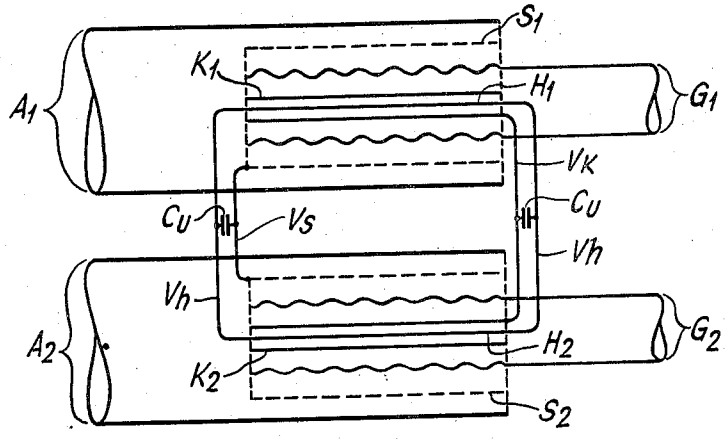
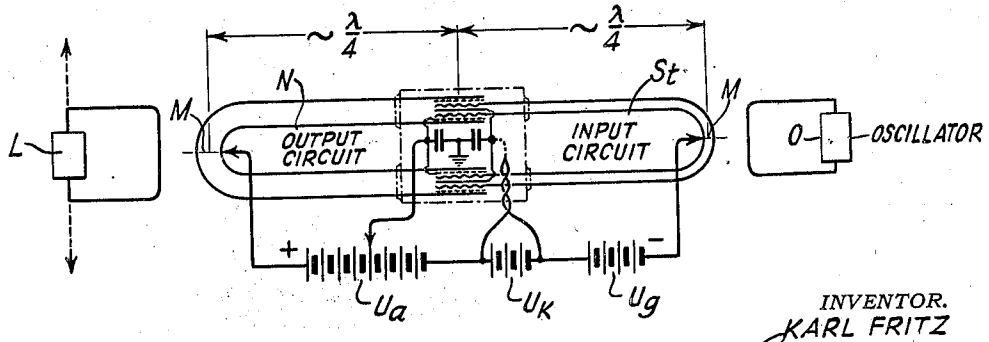


Fig. 3



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PUSH-PULL TUBE ARRANGEMENT

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5 Claims. (Cl. 179—171)

The present invention relates to a push-pull electron discharge device arrangement in which there are employed in the oscillatory circuit inductances in the form of loops of tubing which directly connect with the asociated electrodes, and a pair of space discharge systems arranged parallel to the axes of the tubing and close to each other. The electron discharge device arrangement is preferably used to amplify very short waves. Within the space charger range there are employed ordinary grid controlled space discharge systems. These discharge systems, and at least the adjoining parts of the inductances, are enclosed in a common gas tight vessel.

It is known to employ push-pull electron discharge arrangements using concentric tubings which serve as oscillatory circuits, in which the cathodes are connected together through tuned oscillatory circuits to achieve as favorable an oscillation excitation as possible. Note Hollmann "Physik und Technik der ultrakurzen Wellen," vol. 1, page 227.

The present invention is dealing in, contrary to the known generator arrangements, an arrangement for the amplification and/or frequency multiplication of very short waves, where self-excitation is not only undesirable, but even to be suppressed by all means. In the arrangement according to the invention, preferably normal space charge controlled discharge systems with several open electrodes (grids) are used. Inserting a screen grid proves necessary in order to reduce the action of the natural feed-back through the plate-grid capacity.

If one would continue the known way of designing an amplifier circuit, and would also connect tuned circuits to the screen grids, there would result a very unstable circuit because of the many degrees of freedom affecting the self-excitation, a condition which would render the circuit extremely difficult to adjust even at a single fixed operating frequency. This same difficulty would be encountered in a frequency multiplier circuit. These and similar difficulties are overcome by means of the invention.

In the push-pull electron discharge device arrangement of the present invention, however, wherein the oscillatory circuit inductances are made in the form of loops of tubing which directly connect with the associated electrodes and in which the both discharge systems are arranged parallel to the axes of the tubing and close to each other, it is proposed to connect together the emitting electrodes (cathodes) as well as the screening electrodes (screen grids) directly through practically non-inductive conductors. Preferably the input circuit (grid circuit) and the output circuit (plate circuit) are led out on different sides as seen in the direction of the axes of the systems. Furthermore, for the purpose of complete coupling-out one will turn the planes of the inductance loops by nearly 90° against each other.

Because of the compact construction, due to the connections between similar electrodes being as short as possible in comparison with the wave to be amplified, it is advisable to enclose the both discharge systems, the non-inductive connections between the cathodes and screen grids respectively and at least the adjacent parts of the oscillatory inductances in the common gas tight vessel. The arrangement, according to the invention, offers the advantage that the operating frequency can be altered by known means within the usual limits and there is no necessity for having more tuning circuits than are present in a normal long wave amplifier or multiplier. Besides, by the constructional design of the electrodes and oscillatory circuit inductances, there is obtained a favorable impedance matching and a suitable way of dissipating heat.

In Figs. 1, 2 and 3 there are shown, schematically and by way of illustration only, several circuit arrangements for carrying the invention into practice. Fig. 1*a* shows the preferred form of flat ribbon conductors to be used for the connections between certain electrodes of the electron discharge devices. Fig. 1 shows, primarily, a push-pull electron discharge arrangement in accordance with the invention. The dimensions and the arrangement of the electrodes are chosen such that the circuit connection is easily perceptible. The grid circuit S_t consisting of a loop of metallic tubing runs at its ends immediately into the control electrodes G_1 and G_2. In the following, therefore, the adjacent parts of tubings shall bear the signs of the associated electrodes. The output circuit N lies on the opposite side and is designed in the same manner. The ends of the loop of tubing in this case run immediately into the plates or anodes A_1 and A_2 without changing its shape. Between the plates and the control electrodes, screen grids S_1, S_2 are situated. In the common axis of the both loops of tubing the cathodes K_1, K_2 are situated. The cathodes as well as the screen grids are connected to each other by as short non-inductive conductors as possible (V_k and V_s). Between the both connections, by-pass condensers may be provided, if required. The connections must be as

non-inductive as possible; e. g., in the shape of short wide metal ribbons, as shown in Fig. 1*a*, or concentric tubings in order that no appreciable potential difference may arise between the immediately connected electrodes at the frequency to be amplified. The metal ribbons or tubings serving as connections may simultaneously form the coatings or armature of the by-pass condenser C_u. In order to increase the capacity, a material of high dielectric constant may be inserted. For changing the natural frequency of the oscillatory circuits, means known per se may be used; i. e., for tuning purposes, the loop of the tubing may be shaped into adjustable trombone slides. In using an artificial cooling means, which suitably is carried to and from the point of symmetry M of the oscillatory circuit inductances, it is of advantage to have the loops of tubing unchanged in geometric configuration and to provide variable condensers across the halves of the loops.

Fig. 2 shows, in enlarged form, the two electron discharge devices and associated tubings. Identical reference numbers point to similar elements. Only the design of the connection lead and the shape of the cathode are of particular interest. The emissive parts of the cathodes K_1, K_2 are indirectly heated by heating elements H_1, H_2. The connection of the emissive electrodes to each other is achieved by a short junction V_k. The screen electrodes are connected together by a similar connection V_s. The heating elements H may be connected in series or in parallel by means of junctions V_h. The wiring is in both cases nearly the same; only the links to the heating current source being differently shown. To avoid variations of the surge impedance, the junctions are not all to be led out at one side but equally distributed on both front sides of the discharge systems. To remove any small alternating voltage differences between the junctions, by-pass condensers C_u are provided.

Fig. 3 shows as an example a separately excited short wave transmitter, the principal element of which is an amplifier stage or a frequency multiplier stage, using the push-pull electron discharge device arrangement in accordance with the invention.

The input circuit S_t, e. g., of an amplifier stage, is separately excited from a master oscillator O. The electrical lengths of the input circuit and the output circuit, measured from the middle of the discharge system to the mid-points M (points of symmetry) of the loops of tubing, amount each to about one-quarter of the length of the operating wave. The connections of the cathodes and screen grids respectively to each other are performed according to Fig. 1 or Fig. 2, or a combination thereof. The operating voltages of the control electrodes U_g and of the plates U_a are supplied to the respective points of symmetry M. The output circuit N is coupled to a load circuit consisting, e. g., of an antenna.

The idea of the present invention is not limited to the examples herein described and illustrated. In particular, it is possible to use another kind of discharge system, which, if required, may work within its saturation range. It would be possible, e. g., to utilize this idea in conformity in a magnetron system comprising open or subdivided electrodes; then, however, the appertaining electrode parts, which are, e. g., claw shaped and situated at the ends of the respective tubing loops, would be cophasally excited at a time in contrast to a normal beam type of tube.

What I claim is:

1. A short wave push-pull electron discharge device system comprising a pair of electron discharge devices, each having an anode, a control electrode, a screen electrode and a cathode; a loop of metallic tubing connecting said control electrodes together to form a tuned input circuit for said system; and a loop of metallic tubing connecting said anodes together to form a tuned output circuit for said system, and connections of minimum inductive reactance between said cathodes and between said screen electrodes, said connections by virtue of their spacing and configuration providing a capacitive path of low impedance therebetween.

2. A short wave push-pull electron discharge device system comprising a pair of electron discharge devices, each having an anode, a control electrode, a screen electrode and a cathode; a loop of metallic tubing connecting said control electrodes together to form a tuned input circuit for said system; a loop of metallic tubing connecting said anodes together to form a tuned output circuit for said system; and connections of minimum inductive reactance between said cathodes and between said screen electrodes, said connections comprising parallel conductors of appreciable surface area so arranged relative to each other as to provide a capacity path of low impedance therebetween.

3. A system in accordance with claim 1, characterized in this that said anode and control electrodes constitute extensions of said loops of metallic tubing.

4. A system in accordance with claim 1, characterized in this that said anode and control electrodes constitute extensions of said loops of metallic tubing, there being provided a single gas-tight envelope surrounding said electrodes of both said devices.

5. A short wave push-pull electron discharge device system comprising a pair of electron discharge devices, each having an anode, a control electrode, a screen electrode and a cathode; a loop of metallic tubing connecting said control electrodes together to form a tuned input circuit for said system; a loop of metallic tubing connecting said anodes together to form a tuned output circuit for said system; and connections of minimum inductive reactance between said cathodes and between said screen electrodes; and sources of polarizing potentials connected to the electrical centers of said loops of tubing, each loop of tubing having a length equal to one-quarter of the length of the operating wave as measured from the electrical center of said loop to the center of any one discharge device, said loops being turned at an angle of substantially 90° relative to each other to minimize mutual coupling.

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