July 12, 1960 R. E. CARSON 2,945,158

SIGNAL PROCESSING ARRANGEMENT

Filed March 7, 1957

FIG.1

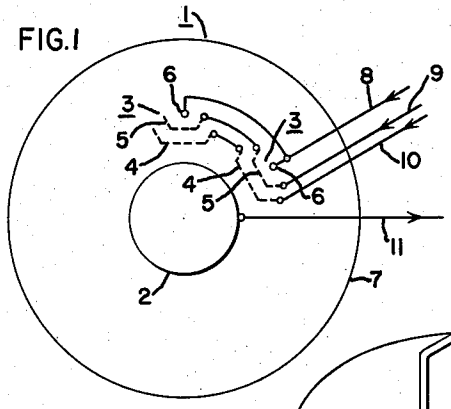


FIG.3

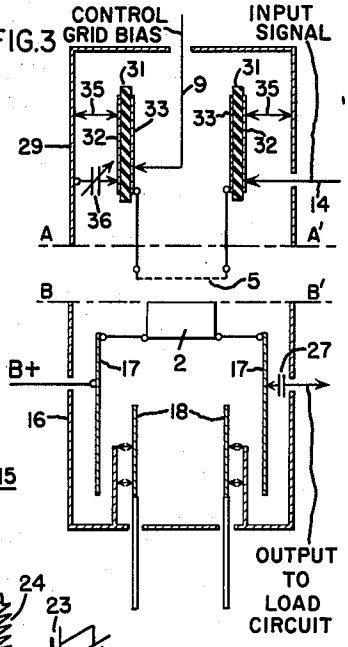


FIG.2

INVENTOR:
ROBERT E. CARSON,
BY Michael Maenike
HIS ATTORNEY.

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SIGNAL PROCESSING ARRANGEMENT

Robert E. Carson, North Syracuse, N.Y., assignor to General Electric Company, a corporation of New York

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9 Claims. (Cl. 315—39)

This invention relates to signal processing arrangements and particularly to control arrangements for signal transducing devices.

In the field of electrical signal processing, it is oftentimes desirable to provide electrical signals at high frequency with minimum complexity of the electrical and mechanical design. The frequency of operation oftentimes dictates a form of cavity resonator construction which inherently introduces mechanical and electrical problems not found in the simpler open transmission line structure employed at lower frequencies. A cavity resonator type construction introduces or increases the problems of tuning, and the problem of bypassing the high frequency signals at the leads supplying biasing and plate voltages which determine the operating conditions, etc.

It is therefore an object of my invention to provide an improved signal processing arrangement.

Another object of my invention is to provide improved means for providing high frequency electrical waves.

Another object of my invention is to provide novel high frequency bypass circuits for use with cavity resonator type signal transducers.

Another object of my invention is to provide an improved cavity resonator signal transducing arrangement.

Another object of my invention is to provide improved input and output circuits for use with high frequency signal transducing arrangements.

Another object of my invention is to provide an improved electrical arrangement comprising an improved input and output circuit for use with a signal transducing arrangement employing a plurality of control electrodes.

In accordance with an embodiment of my invention, high frequency amplification of electrical signals is obtained by means of a high-powered tetrode amplifying device tuned by an input cavity resonator which comprises, effectively, half wave length open-ended transmission line.

The resonator design permits a shorter physical length of the tuning cavity and eliminates the need for complex high frequency bypassing circuits. Where a high frequency bypass circuit is required, I have provided a novel arrangement comprising effectively a quarter wave open-ended transmission line of cylindrical construction.

The features of the present invention which are believed to be novel are particularly pointed out in the appended claims.

Fig. 1 illustrates schematically a high frequency power amplifying stage comprising an electron discharge device in the form of a single plate electrode surrounded by a plurality of control electrodes, Fig. 2 illustrates part pictorially and part in block diagram form an embodiment of the present invention, and Fig. 3 illustrates in simplified pictorial form a further embodiment of the present invention.

Referring to Fig. 1 there is shown a signal amplifier comprising an electron discharge device 1. Said device comprises an inner plate electrode 2 having associated with it a plurality of control electrode arrangements 3.

Each of said arrangements 3 comprise a screen electrode 4, a control electrode 5, and a cathode electrode 6. All of the electrodes are mounted within the evacuated envelope 7. It is desirable, under certain conditions, to provide a single input circuit and a single output circuit with such an amplifying device. In a preferred embodiment, the input and output signal connections are made as shown with a cathode voltage being applied to all of the cathodes in common over lead 8, a grid bias signal applied in common to all of the control electrodes 5 over lead 9, a screen bias voltage applied to all of the screen electrodes 4 over lead 10, and the B+ potential for the plate electrode 2 over lead 11. The input and output circuits for use with such a structure can best be analyzed by reference to Fig. 2.

For purposes of simplicity elements common to Figs. 1 and 2 have been identified by the same reference number. For purposes of simplification, Fig. 2 has been drawn to represent only one set of control electrode arrangements associated with the common plate electrode 2. This has been represented in Fig. 2 by providing a single tuning input circuit shown above the dotted line AA' and a single output circuit shown below the dotted line BB'. It should be noted that the single plate electrode 2 is shown below the dotted line BB'. The plurality of control electrode arrangements of Fig. 2, associated with the common plate electrode, are shown, for purposes of simplicity, as a single cathode electrode 6, a single control electrode 5, and a single screen electrode 4 between the sections AA' and BB'.

It is desirable to take high frequency power in the form of electrical signals from the high frequency signal source 12 and amplify them to a suitable level before delivering them to the output circuit 13. Signals from source 12 are applied over the coaxial line 14 to the input cavity resonator circuit 15. The input cavity resonator is designed to simulate a folded half-wave length open-ended transmission line coupled between the cathode electrode 6 and the control electrode 5. The input cavity resonator comprises an outer conductor 16 having associated therewith two inner conductors. The inner conductors comprise a first and second cylindrical conductor 17 and 18 respectively. Conductor 17 is connected at one end to the control electrode 5 and spaced at the other end from the outer conductor 16. Conductor 18 comprises two sections 19 and 21. The section 19 comprises a fixed length cylindrical conductor connected at one end to the outer conductor 16 and conductively connected at the other end by means of spring fingers 20 to the adjustable length cylindrical conductor 21. The length of conductor 21 within the cavity resonator 15 may be varied by means of control rod 22. The conductor 21 passes through an annular gap of the conductor 16. Bias for the control electrode 5 is provided from source 23 by means of the grid bias resistor 24, the connection 9 and the movable contact 25 conductively contacting the cylindrical conductor 17. Cathode voltage is provided from source 26 over lead 8 to the cathode electrode 6.

Coupling condenser 27 associated with the coaxial line 14, has a sliding contact which is movably adjustable along the conductor 17 in order to match the impedance of the input cavity resonator to that of the high frequency source 12. By providing in effect a folded, open-ended transmission line, applicant is able to compress the size of the cavity resonator, thereby simplifying the electrical and mechanical design, and also eliminating the need for a high frequency bypass condenser between the grid 5 and the inner conductor 17. Thus by providing a folded transmission line *abc*, effectively a half wave length long, and open at the end *c*,

the need for a high frequency bypass condenser at point *b* is eliminated.

The output cavity resonator **28** comprises an outer conductor **29** and an inner conductor **30**. Inner conductor **30** comprises a cylindrical section **31** formed of a suitable dielectric material such as quartz, having an electrically conductive outer surface **32** and an electrically conductive inner surface **33**. This arrangement is electrically dimensioned to be a ¼ wavelength long at the system operating frequency such as to transform an open circuit at one end thereof to a short circuit at the plate electrode end. The inner surface **33** is connected by means of the movable contactor **34** to the plate electrode **2**. The frequency of the output cavity is determined by means of the movable shorting plunger annular ring **35** connected between the conductor **29** and the surface **32**. For further tuning control, an adjustable capacitor **36**, which may be a vacuum capacitor, is connected between the outer conductor **29** and the surface **32**. Output load circuit **13** is connected by means of a coaxial line **37** having an inner conductor **38** which may be adjustably connected to a point **39** along the length of the surface **32**. Capacitor **40** constitutes the radio frequency bypass capacitor for the B+ supplied to the plate electrode **2**.

Although the invention has been described in a manner such that the input cavity resonator comprises the folded open-ended transmission construction and the output cavity resonator comprises a short circuited transmission line construction, these constructions may be employed in the input or output cavity resonator portions. Fig. 3 illustrates one such alternative construction. Elements common to Figures 2 and 3 have been identified by common reference numerals.

While a specific embodiment has been shown and described, it will of course be understood that various modifications may yet be devised by those skilled in the art which will embody the principles of the invention and found in the true spirit and scope thereof.

What I claim and desire to secure by Letters Patent of the United States is:

1. In combination, a signal amplifier comprising a single plate electrode, a pluality of separate cathode electrodes, a plurality of separate control electrodes, and a plurality of separate screen electrodes, all of said separate electrodes electrically cooperating with said single plate electrode, means simulating a folded half wave length open-ended transmission line connected between said cathodes and control electrodes comprising a cavity resonator, said resonator comprising a cylindrical outer conductor connected at one end to said cathode electrodes, and an inner conductor, said inner conductor comprising an outer cylinder connected to said control electrodes and an inner cylinder adjustable in length and connected at one end to the other end of said outer conductor.

2. In combination, a cavity resonator comprising a tubular outer conductor having an electrode positioned near one end thereof a tuned resonant low impedance coupling arrangement comprising a tubular inner conductor of dielectric material mounted within said cavity resonator and having electrically insulated inner and outer electrically conductive surfaces thereon, means for coupling said electrode to said inner surface at one end of said inner conductor, and means for extracting output signals coupled to said outer surface, said inner conductor having a length so as to constitute an odd integral multiple of a quarter wave open-ended line at the frequency of the output signals.

3. In combination, a signal transducing device comprising a tubular outer conductor having an electrode positioned near one end thereof and being closed at the other end, a folded open-ended transmission line coupled between said outer conductor and said electrode comprising a pair of spaced concentric inner conductors mounted within said outer conductor, means for connecting said electrode to the outermost one of said inner conductors, means for connecting the innermost of said inner conductors to the other end of said outer conductor, means for coupling an input signal to the transmission line portion formed by said outer and outermost conductors, and means for varying the length of said innermost conductor to vary the dimensions of the transmission line portion formed by said inner conductors.

4. In combination, a signal transducing arrangement comprisingly a plurality of input electrodes and a single output electrode, a tubular outer conductor, a folded open-ended transmission line coupled between said outer conductor and said input electrodes comprising first and second concentric tubular inner conductors, said first conductor spaced from said outer conductor and connected to said input electrodes so as to form a first transmission line portion with said outer conductor, said second conductor forming a second transmission line portion with said first conductor and being connected at one end to said outer conductor, said input electrodes being physically interposed between said output electrode and said first conductor so to separate them from each other, and means for adjusting the length of said second conductor.

5. In combination, a signal transducing arrangement comprising a first electrode, a plurality of separate second electrodes, all of said separate electrodes cooperating electrically with said first electrode, a cavity resonator, said resonator comprising a tubular outer conductor closed at one end by a wall portion and a pair of concentric tubular inner conductors, said first electrode located near the other end of said outer conductor, the outermost of said inner conductors being spaced from said wall portion and connected to said second electrodes so as to form with said outer conductor a first transmission line portion, the innermost of said inner conductors having one end connected to said wall portion, and means for varying the dimensions of the second transmission line portion formed between said inner conductors comprising means for varying the length of said innermost conductor.

6. In combination, a signal transducing device comprising a tubular outer conductor having a control electrode positioned near one end thereof and being closed by a conductive wall portion at the other end thereof, a pair of spaced concentric inner conductors mounted within said outer conductor, one end of the outermost one of said inner conductors being electrically insulated from said wall portion, means for conductively connecting said control electrode to the other end of said outermost one of said inner conductors, means for conductively connecting the innermost of said inner conductors to said wall portion of said outer conductor, means for coupling an input signal through said outer conductor to the cavity resonator portion formed by said outer and outermost conductors, means for varying the length of said innermost conductor to vary the cavity resonator portion formed by said inner conductors, a second cavity resonator comprising a tubular outer conductor having an output electrode positioned near one end thereof, a tubular inner conductor of dielectric material mounted within said second cavity resonator and having electrically insulated inner and outer electrically conductive surfaces thereon, means for coupling said output electrode to said inner surface, and means for extracting output signals coupled through said second cavity outer conductor to said outer surface.

7. A cavity resonator comprising a tubular outer conductor closed at one end by a wall portion, a control electrode positioned within said outer conductor, a folded open-ended transmission line coupled between said tubular outer conductor and said control electrode comprising a pair of concentric tubular inner conductors mounted

within said outer conductor, the outer most of said inner conductors having one end connected to said control electrode and the other end spaced from said wall portion forming with said outer conductor a first transmission line portion, the inner most of said inner conductors having one end connected to said wall portion and the other end forming with said outer most conductor a second transmission line portion.

8. A cavity resonator for tuning an electron discharge device, said resonator consisting of a folded open-ended transmission line comprising a tubular outer conductor closed at one end by a wall portion, a pair of concentric tubular inner conductors mounted within said outer conductor, the outer most of said inner conductors being spaced from said wall portion forming with said outer conductor a first portion of said transmission line, the inner most of said inner conductors having one end connected to said wall portion and the other end forming with said outer most conductor an open-ended portion of said transmission line, and means for varying the dimensions of transmission line portion formed between said inner conductors, said means comprising means for varying the length of said inner most conductor.

9. In combination, a cavity resonator comprising a tubular outer conductor having a first electrode positioned near one end thereof, a tubular member of dielectric

material mounted concentrically within said outer conductor and having electrically insulated inner and outer conductive surfaces thereon, means for coupling said first electrode to said inner surface at one end of said tubular member, a second electrode coupled to said outer conductor, signal means, means coupling said signal means in circuit between said first and said second electrode comprising means to couple said signal means to said outer surface, said tubular member having a length so as to constitute an odd integral multiple of an open quarter wave length section at the frequency of the signal at said signal means, a conductive end wall portion connected between said outer conductive surface and said outer conductor at its other end.

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CERTIFICATE OF CORRECTION

Patent No. 2,945,158 July 12, 1960

Robert E. Carson

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 42, for "pluality" read -- plurality --; line 58, after "thereof" insert a comma; column 4, line 11, for "comprisingly" read -- comprising --.

Signed and sealed this 27th day of December 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents