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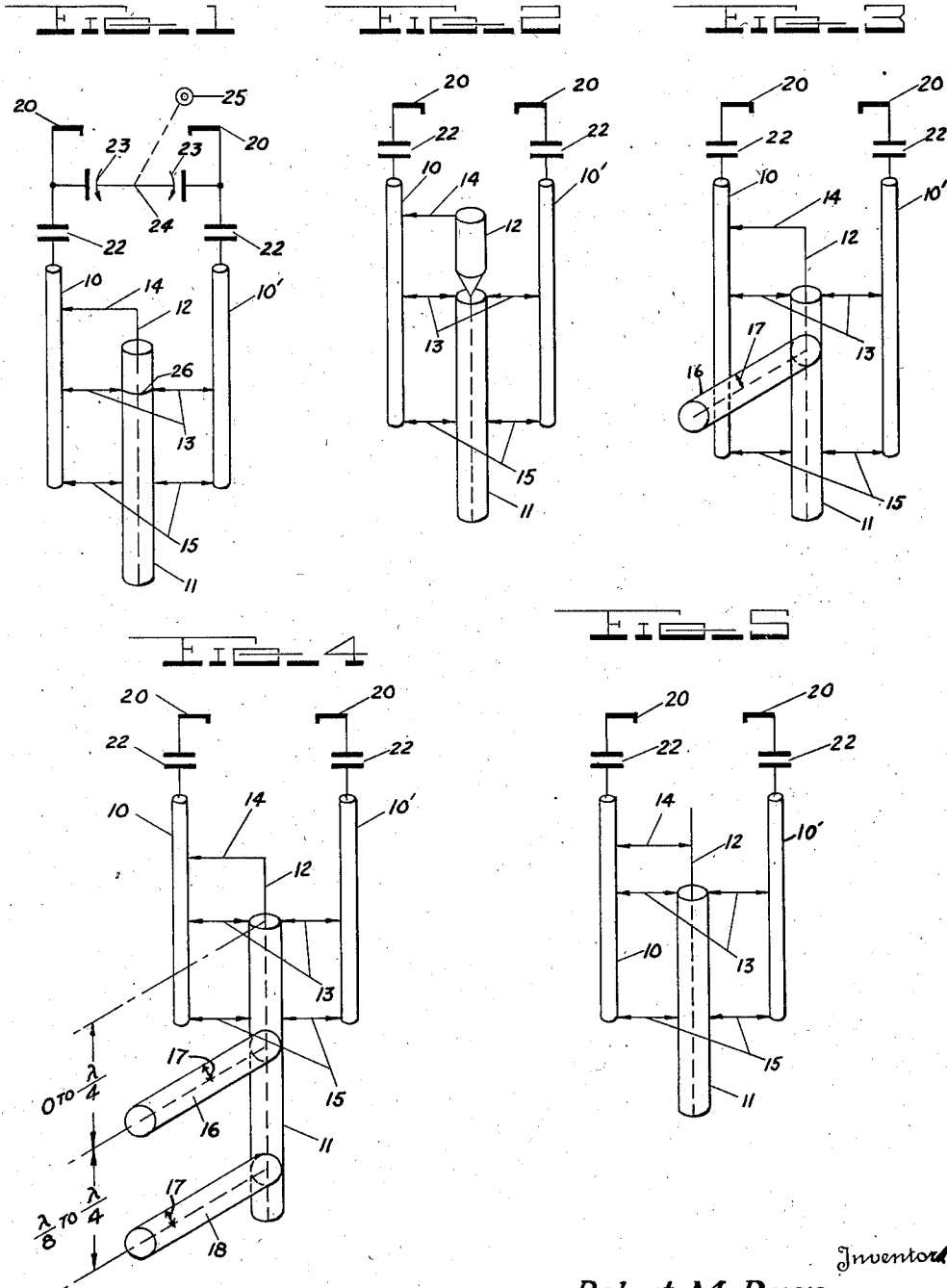
R. M. PAGE ET AL

2,426,236

COUPLING SYSTEM

Filed Aug. 25, 1942

2 Sheets-Sheet 1



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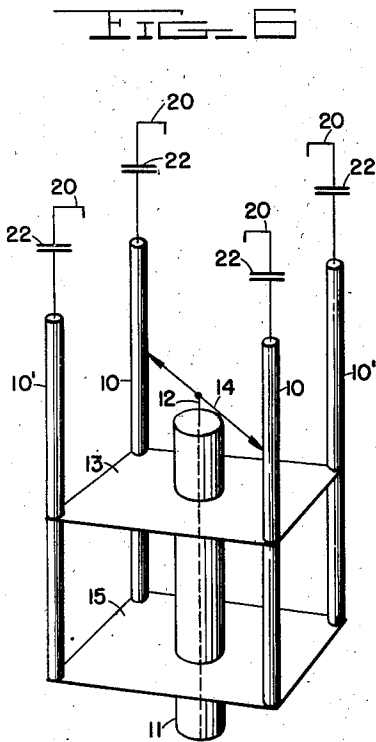
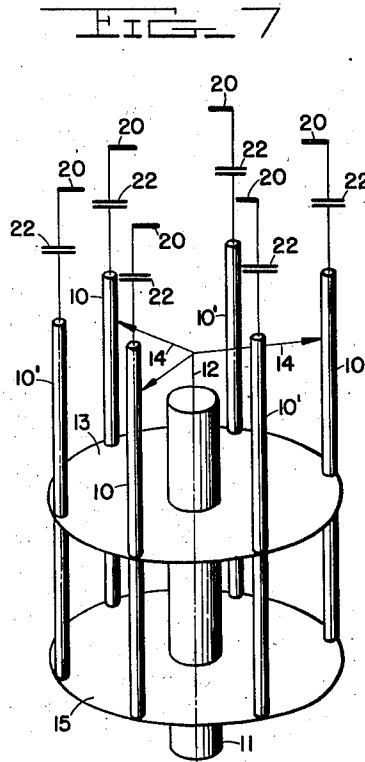
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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COUPLING SYSTEM

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12 Claims. (Cl. 178—44)

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This invention relates to a means for coupling a plurality of high frequency output circuits to a transmission line. It is particularly adapted to coupling the output of a high frequency multi-tube oscillator to a transmission line as shown in the application of Robert M. Page et al., Serial No. 456,045, filed August 25, 1942, for Oscillator. In that application it is used to couple the filament circuits of the multiple tube shorted plate oscillator to an antenna circuit.

It is an object of this invention to provide a coupling system which will couple a plurality of high frequency output circuits to a transmission line at high power levels with proper impedance matching to reduce radiation losses to a minimum.

Another object is to provide a coupling system having the foregoing characteristics which will lend itself readily to accurate tuning in synchronism with tuning of the output circuits to maintain a high coupling efficiency over a wide frequency range.

A further object is to provide a coupling system capable of easy and accurate adjustment for the variation of the coupling.

Other objects will become apparent from a careful consideration of the following description when taken in conjunction with the accompanying drawings in which:

Figs. 1 to 5 inclusive are schematic diagrammatic showings of the various embodiments of the invention as applied to a pair of high frequency output circuits. Figs. 6 and 7 are diagrams, partly schematic, of embodiments of the invention as applied to four and six high frequency output circuits respectively.

The system in general employs one frame for each of the output circuits, the frames being located in mutual parallelism and being equidistant from a common central axis and equally spaced from each other. In the drawings the system is shown as applied to either two, four, or six output circuits, but it should be distinctly understood that any even number of output circuits may be employed. In each case the number of frames used will equal the number of output circuits and their arrangement will be modified to secure the spacing described above.

In Fig. 1 is shown a pair of frames 10 and 10' to which is coupled a transmission line having an outer conductor 11 and an inner conductor 12. In this form of the invention the outer conductor of the transmission line is shorted to the frames by means of a shorting bar 13 positioned below the upper end of the outer conductor. The inner

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conductor 12 is continued upwardly above the outer conductor and is coupled to one of the frames 10 by means of a coupling bar 14. An end bar 15 is provided at the lower extremities of the frames for the sole purpose of adding stability and rigidity to the assembly. If a greater number of frames are employed, the inner conductor will be shorted to each alternate one of the frames. For example, if four frames were employed, the inner conductor would be shorted to a pair of frames diagonally located with respect to the assembly. If six frames were employed the inner conductor would be shorted to three of them. If more than two output circuits are to be coupled, the shorting bar and end bar become plates. The four frame arrangement is shown in Fig. 7.

This basic construction is followed throughout all of the modifications disclosed herein. The differences between the construction of Fig. 1 and other forms of the invention lie solely in the means used to secure accurate tuning of the frames. The means employed in the form shown in Fig. 1 may either be a variation of the location of the shorting bar 13 or of the coupling bar 14 or it may be accomplished by varying the height of the portion of conductor 11 extending above bar 13. The coupling bar may be varied in location by making the inner conductor 12 telescopic in form or the variation may be accomplished by sliding the coupling bar 14 along the inner conductor as illustrated in Fig. 5. The upper portion of conductor 11 may be made telescopic as indicated at 26 in Fig. 1.

In Fig. 2 the shorting bar 13 is shown located at the upper extremity of the outer conductor 11 and the diameter of the portion of the inner conductor 12 protruding above the outer conductor has been enlarged substantially to the diameter of the outer conductor 11. The purpose of the enlargement is the reduction of the inductance of this portion of the inner conductor. The greater the enlargement, the lower its inductance will be. The degree of enlargement is not limited to the diameter of the outer conductor 11. Tuning in this form of the invention may be accomplished by moving the coupling bar 14 along the enlarged portion of the inner conductor 12, by varying the length of the protruding portion of the inner conductor 12 or by varying the location of the shorting bar 13 with respect to the upper extremity of the outer conductor 11. Any one or a combination of these expedients may be employed for this purpose. The variation in the length of the inner conductor 12 may be accom-

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plished by making the protruding portion of a telescopic nature. In the form of the invention shown in Fig. 3 tuning is accomplished by means of a stub line 16 positioned just below the shorting bar 13. The electrical length of this stub is varied by means of a short-circuiting member 17.

Fig. 4 illustrates the use of a pair of reactance stubs 16 and 18 by means of which a wide range of impedance transformation may be secured. The stubs are preferably one-half wave in length and may be spaced at various locations to vary the desired range of transformation.

If the impedance required to properly load the oscillator is lower than the characteristic impedance of the transmission line then the stub 16 should be spaced one-quarter wave length from the shorting bar. If the impedance required to properly load the oscillator is higher than the characteristic impedance of the line then the stub 16 should be placed at the shorting bar.

The spacing between stubs depends upon the range of transformation desired. If the transmission line is properly terminated at its load end and if the two stubs are spaced one-quarter wave length apart, then the impedance at the input to the transformer can be made to vary from a value equal to the characteristic impedance of the line up to infinity. Moving the stubs closer together increases the range until at a space of one-eighth wave the range extends from one-half the characteristic impedance of the line to infinity. Although the range can be further increased by a decrease in the spacing the setting becomes more highly critical as the stubs are brought closer together. A spacing of one-eighth wave length has been found to operate satisfactorily but the critical nature of the setting has been found to render spacings much closer than this undesirable.

The electrical length of each of the reactance stubs of Fig. 4 may be varied for tuning purposes by means of a short-circuiting member such as 17.

While many forms of compensating means have been shown one or more may be employed together in a single embodiment, as for example, the telescopic inner conductor 12 together with the variable shorting bar 13 and a compensating stub 16.

A coupling system such as disclosed herein lends itself readily to tuning by means of a ganged tuning means by the conjunction of the tuning of the output circuits. An illustration of this is found in the above mentioned application of Robert M. Page et al., in which ganged tuning means are employed to tune the grid circuits of a multi-tube oscillator simultaneously with the tuning of the filament frames which are coupled to a transmission line in accordance with the invention. This tuning is accomplished by means of variable condensers, located between filament circuits and simultaneously tuned by means of a butterfly type tuning vane which also acts to complete a capacitive circuit between the filaments. Such a tuning arrangement has been indicated in Fig. 1 which shows filaments 20 and 20' of a two-tube oscillator, each filament being connected to a respective one of the filament frames through bypass capacitors 22 and 22' respectively. Variable condensers 23 and 23' are shown connected between the filaments and simultaneously variable by conductor 24 which is shown connected to the operating knob 25.

The employment of filament frames in this manner makes available a convenient shielding means through which the filament leads may be led from the high voltage region of an oscillator

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and the filament frames themselves become rigid structural components of the oscillator assembly. The coupling device is mechanically strong and rugged.

It should be understood that the practice of the invention is not limited to the embodiments illustrated and described but is circumscribed only by the scope and limitations of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

We claim:

1. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, and means conductively connecting the inner conductor of said transmission line to the alternate ones of said conductors in a plane intermediate said above mentioned planes and parallel thereto.

2. Means for coupling an even number of high frequency output circuits to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the outer conductor of said transmission line terminating in a second plane parallel to the first mentioned plane, the inner conductor of said transmission line terminating in a third plane intermediate the above mentioned planes and parallel thereto, means conductively connecting the termination of said outer conductor to said rigid conductors in said second plane and means conductively connecting said inner conductor to alternate ones of said rigid conductors in said third plane.

3. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, said outer conductor terminating intermediate said planes, the inner conductor of said transmission line terminating in a third plane intermediate the first mentioned plane

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and the termination of said outer conductor, and means conductively connecting said inner conductor to alternate ones of said rigid conductors in said third plane, said short-circuiting means being movable along said outer conductor and said rigid conductors to vary the coupling between said rigid conductors and said transmission line.

4. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, and means conductively connecting the inner conductor of said transmission line to alternate ones of said conductors in a plane intermediate said above mentioned planes and parallel thereto, said conductive connecting means being movable to vary the coupling between said rigid conductors and said transmission line.

5. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last-named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, the inner conductor of said transmission line being terminated intermediate said planes and means conductively connecting the termination of said inner conductor to alternate ones of said rigid conductors, at points lying in a third plane parallel to the above mentioned planes, said inner conductor being telescopic whereby said conductive connecting means may be moved to move said points of connection and thereby vary the coupling between said rigid conductors and said transmission line.

6. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, the inner conductor of said transmission line extending beyond

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said outer conductor, the diameter of the protruding portion thereof being increased beyond its normal value and said protruding portion being telescopic, and means conductively connecting the end of said protruding portion to alternate ones of said rigid conductors, said connecting means being movable with the end of said protruding portion to vary the points of connection of said connecting means with said rigid conductors.

7. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last-named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, the inner conductor of said transmission line extending beyond said outer conductor, the diameter of the protruding portion thereof being increased beyond its normal value, and means conductively connecting the end of said protruding portion to alternate ones of said rigid conductors.

8. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last-named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, means conductively connecting the inner conductor of said transmission line to alternate ones of said conductors in a plane intermediate said above mentioned planes and parallel thereto, a reactance stub connected into said transmission line adjacent said second plane, and means for varying the electrical length of said stub.

9. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last-named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, means conductively connecting the inner conductor of said transmission line to alternate ones of said conductors in a plane intermediate said above mentioned planes and parallel thereto, a pair of reactance stubs connected into said transmission line, the con-

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nection point of one of said stubs being spaced from said second plane by a distance equal to one-quarter wave length of the output circuit frequency and the connection point of the other being spaced from the first mentioned connection point by a distance lying between an eighth and quarter wave length, and means for varying the electrical length of said stubs.

10. Means for coupling the output circuits of an even number of high frequency electronic tubes to a concentric transmission line, comprising a like number of rigid conductors, said conductors extending in mutual parallelism, being equally spaced from each other and from a central axis of symmetry coaxial with said transmission line, and terminating in a plane normal to said axis, means coupling each of said circuits to the termination of one of said conductors, and means coupling said conductors to said transmission line, the last-named coupling means comprising means short-circuiting the outer conductor of said transmission line to all of said rigid conductors at points lying in a second plane parallel to said plane of termination, means conductively connecting the inner conductor of said transmission line to alternate ones of said conductors in a plane intermediate said above mentioned planes and parallel thereto, a pair of reactance stubs connected into said transmission line, one of said stubs being connected into said line in said second plane and the connection point of the other being spaced from said second plane by a distance lying between an eighth and a quarter wave length, and means for varying the electrical length of said stubs.

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11. Means for coupling a pair of high frequency circuits to a concentric transmission line comprising a pair of rigid conductors equally spaced in parallelism from the central axis of said transmission line and terminating in a plane normal to said axis, means coupling each of said circuits to separate conductors of said pair of conductors, and means coupling said conductors to said transmission line, the last-named means including short-circuiting means connecting the outer conductor of said transmission line to said pair of conductors in said plane of termination, and means conductively connecting the inner conductor of said transmission line to one of said conductors at a point thereon intermediate said plane of termination and said circuits.

12. Means for coupling an even number of high frequency circuits to a concentric transmission line comprising a plurality of conductors equally spaced in parallelism from each other and from the central axis of said transmission line, means connecting each of said circuits to a separate conductor of said plurality of conductors, means connecting each conductor of said plurality of conductors to the outer conductor of said transmission line in a first plane normal to said axis, and means connecting alternate conductors of said plurality of conductors to the inner conductor of said transmission line in a second plane normal to said axis intermediate said first plane and said circuits.

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