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2,425,328

SWITCHING AND MODULATION SYSTEM

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FIG. 1

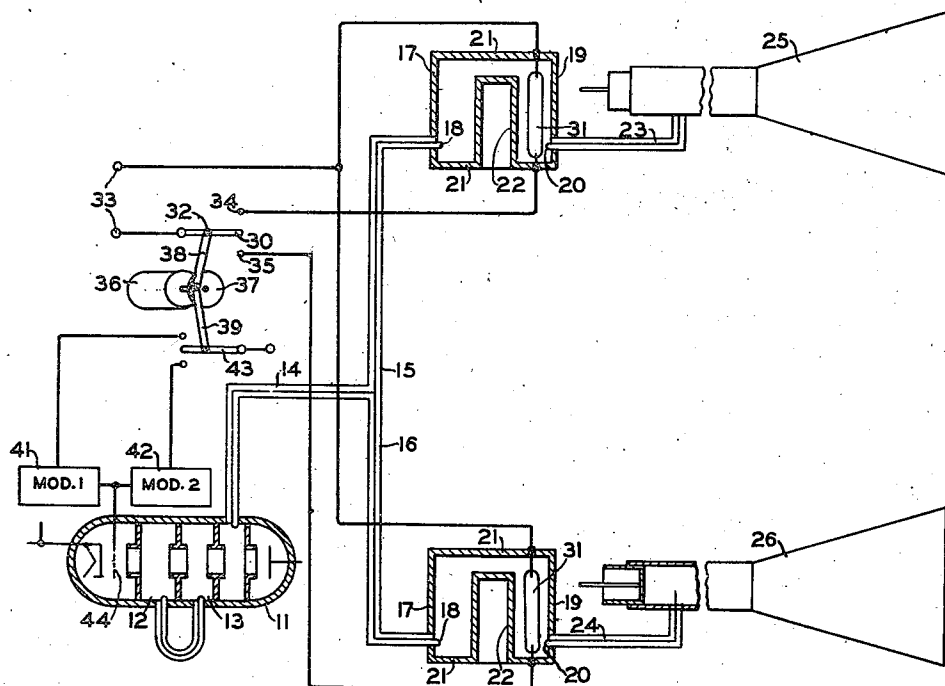
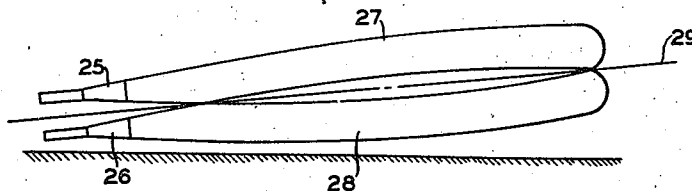


FIG. 2



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SWITCHING AND MODULATION SYSTEM

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24 Claims. (Cl. 250-11)

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This invention relates to switching and modulation systems and, more particularly, to methods of and apparatus for regulating the flow of electromagnetic energy from a source of oscillations to one or more load circuits. This application is a continuation-in-part of application Serial No. 386,766, filed April 4, 1941, now Patent 2,408,425, issued October 1, 1946.

Although it is customary to regulate the flow of radio frequency energy from a source of oscillations to one or more load circuits, some difficulty ordinarily is encountered in obtaining a smooth switching action without forming undesirable surges or higher order harmonics that detract from normal operation, especially where the oscillations to be controlled are of ultra high frequency. In the present invention, use is made of a high-Q resonant circuit, such as is provided by a cavity resonator, having a natural frequency in the general region of the source of high frequency oscillations for coupling the source with the load circuit. By slightly varying the natural frequency of the resonator, the amount of energy which it absorbs from the source and in turn supplies to the load circuit may be controlled. By virtue of the extremely high Q which cavity resonators possess, the natural frequency may be varied over a wide range with but little change in the physical or electrical characteristics. Although the invention is herein described as applied to an ultra high frequency equi-signal type instrument landing system, it is obvious that the same principles may be utilized in other applications.

One of the objects of the present invention lies in the provision of a novel instrument landing system employing gaseous tube discharge means for alternately suppressing the outputs of the two radiation means synchronously with the shift in modulation supplied to the high frequency oscillator.

A second object is to provide an improved switching system wherein the flow of electromagnetic energy from a source to one or more load circuits is controlled by periodically tuning and detuning a cavity resonator coupling the source with the load.

Other objects and advantages will become apparent from the specification, taken in connection with the accompanying drawing, wherein the invention is embodied in concrete form.

In the drawing,

Fig. 1 is a diagrammatic view of a plurality of resonators interposed between an ultra high frequency source and a pair of radiators, together

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with detuning means for controlling the flow of energy to the respective radiators; and

Fig. 2 is a schematic side view showing the overlapping radiation patterns produced by the dual radiators.

Generally speaking, the invention comprehends interposing a cavity resonator in each of the paths connecting an ultra high frequency source with one or more load circuits. Each resonator is provided with input and output coupling means for transferring energy from the source to the load circuit when the resonator is tuned to the frequency of the source. Tuning means within the resonators control the natural frequency of the resonator and regulate the amount of energy flow. By way of illustration, the tuning means are herein shown as gaseous discharge tubes capable of altering the electrical characteristics of each resonator when the tube is energized above the flashing potential.

As applied to a transmitter, the source of electromagnetic oscillations may comprise a generator such as a velocity modulation tube 11, for example, of the type described in R. H. Varian Patent No. 2,242,275, dated May 20, 1941. The tube 11 preferably comprises an oscillator 12 and one or more buffer stages 13 to stabilize the output frequency under varying load conditions. A transmission line 14, herein shown as a concentric cable, conducts radio frequency energy from the output stage of tube 11 to a pair of branch lines 15 and 16. Although the tube 11 may be used to energize as many lines as are desired, and the switching mechanism to be described may likewise be used for successively energizing as many load circuits as are desired, the present invention has been disclosed herein as applied to but two separate load circuits for simplicity in description. Each of the branch lines 15 and 16 terminates in a high-Q cavity resonator 17 of conventional construction. Input loops 18 or similar coupling devices may be provided for transferring the energy from the branch lines to the resonator. The resonators shown may comprise a cylindrical casing 19, end walls 21, and a re-entrant portion 22. Energy is fed from the resonator through coupling devices 20 to a pair of distribution lines 23 and 24 which energize suitable load circuits 25 and 26 respectively. As herein shown, the load circuits comprise ultra high frequency radiating horns, of the type adapted to form directive radiation patterns 27 and 28, as shown in Fig. 2. Each of the patterns preferably is individually characterized as will appear, and the patterns themselves partially overlap to de-

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fine an equi-signal path 29, useful for the instrument landing of aircraft.

The flow of energy from the source 11 to the load circuits is regulated according to the proximity of the natural frequency of the resonators to the frequency of the source 11. The natural frequency may be controlled by tuning devices 31 herein shown as a section of gaseous discharge tubing, disposed in the chamber in such a position as not to be energized when the cavity resonator is excited. The maximum controlling effect will be realized if the tubing is disposed in the maximum electric field. The tuning devices may be actuated by external control means, herein shown as a suitable electronic or mechanical switch mechanism 32, which operates to apply a voltage above the flashing potential to the tubes 31, as from a suitable source of direct or alternating current 33. If desired, the switch mechanism 32 may comprise a single-pole, double-throw type switch having a blade 30 connected to one terminal of the source 33 and having connections 34 and 35 extending to the respective devices 31. By connecting the opposite terminal of each of the devices 31 to the remaining terminal of the source 33, the tubes 31 may be lighted individually, according to the position of the blade 30.

If it is desired to periodically alternate the flow of radio frequency energy to the respective circuits 25 and 26, use may be made of an automatic device 36 for operating the switch 32. As herein schematically shown, such a device may comprise a constant speed motor having a cam or crank 37 and rod 38 for moving the blade of switch 32 alternately into engagement with connections 34 and 35. As more completely disclosed in the parent application, the source 11 may be modulated at one or more audio frequencies, and it is possible to alternate the frequency of audio modulation in synchronism with the action of switch 32. A simple schematic arrangement for operating in this manner is disclosed in Fig. 1, wherein a pair of modulators 41 and 42 may be energized successively by a switch 43 whose operation is controlled by crank 37 and an additional rod 39. The output of the respective modulators may be fed to the grid 44 of the velocity modulation tube or other source, whereby the radio frequency energy is modulated at one audio frequency during the time that one circuit 25 is energized, and at another audio frequency when the other load circuit is energized.

Energizing the tuning devices 31 may be employed to render the resonators 17 resonant to the frequency of the source of oscillations, but it is preferred to have the resonators normally tuned to the frequency of the source, for maximum energy transfer, and to detune the resonators when the respective gaseous discharge tubes are energized. Various types of gaseous discharge tubes may be used, but satisfactory results have been obtained with sections of neon tubing having the customary terminal connections. If the switch 32 is operated at audio frequency, the radio frequency energy conducted to either load circuit may be modulated by recurrently detuning the resonator, even though the source comprises unmodulated oscillations. By the reciprocity theorem, the load and source may be interchanged without affecting the operation of the system, the principles being equally applicable whether utilized in transmitting or receiving radio frequency energy.

As many changes could be made in the above construction and many apparently widely differ-

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ent embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an instrument landing system of the character described, a pair of electromagnetic radiators, an ultra high frequency generator, means connecting the output of said generator to said pair of radiators, hollow resonator means having an electron discharge tube disposed thereon included in said connection and normally tuned to the output of said generator, and means for causing the detuning of said hollow resonator means to effect alternate energization of said radiators.

2. In an instrument landing system of the character described, a pair of electromagnetic radiators, an ultra high frequency generator, means connecting the output of said generator to said pair of radiators, a pair of hollow resonators having an electron discharge tube contained therein, a respective one of said resonators being included in the connection between each radiator and said generator, said resonators normally being tuned to the output of said generator, and means for alternately detuning said resonators.

3. In an instrument landing system, a pair of directive electromagnetic radiation members, wave guide means interconnecting said members, means for supplying electromagnetic energy to a point of said wave guide means, resonators associated with said wave guide having a gaseous discharge tube disposed therein means on opposite sides of said point of supply, and means for alternately tuning and detuning said resonators to direct energy in sequence to said radiation members.

4. In an instrument landing system, means for radiating a pair of beams of high frequency energy having non-coincident axes, a high frequency energy source, individual paths connecting said radiators and source, each having a cavity resonator, said cavity resonator having an electron discharge tube disposed therein, and means for alternately tuning and detuning said resonators to produce a periodic switching of high frequency energy to said radiators.

5. A transmission system comprising a source of radio frequency oscillations, a load circuit, and a cavity resonator having an electron discharge tube disposed therein normally tuned to the frequency of said oscillations for coupling said source with said circuit, and means for detuning said resonator to vary the coupling between said source and said circuit.

6. A transmission system comprising a source of radio frequency oscillations, a load circuit, and a cavity resonator having an electron discharge tube disposed therein tunable to the frequency of said oscillations for coupling said source with said circuit, and recurrently operable means for altering the natural frequency of said resonator to periodically vary the coupling between said source and said circuit.

7. A transmission system for controlling the flow of radio frequency energy from a source of oscillations to an energy-utilizing circuit, comprising a cavity resonator having an electron discharge tube disposed therein normally tuned to the frequency of said source, coupling means for connecting said resonator with said source and

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with said circuit respectively, and means for energizing said tube so as to detune said resonator and alter the flow of energy from said source to said circuit.

8. A switching circuit for regulating the flow of energy from a source of radio frequency oscillations to a plurality of load circuits, comprising a cavity resonator in each of the paths connecting said source and said respective circuits, and electron discharge means disposed within said resonator for altering the natural frequency of said respective resonators successively.

9. A cavity resonator for use as an energy control device placed between an electrical source and a load in a multiple-branch transmission line system, comprising a gaseous discharge tube disposed within said resonator and adapted when energized to alter the natural frequency of oscillations of said resonator so as to block the flow of energy from said source to said load.

10. A switching circuit for regulating the flow of energy from a source of radio frequency oscillations to a plurality of load circuits, comprising a cavity resonator in each of the paths connecting said source and said respective circuits, said resonators being tunable to the frequency of said oscillations, tuning means recurrently operable for altering the natural frequency of said respective resonators in succession, said tuning means comprising a gaseous discharge device in each of said resonators, and means for exciting said devices successively to above a flashing potential, whereby said energy is cyclically switched of said respective circuits.

11. A cavity resonator for use as an energy control device placed between a source and its load in a multiple-branch transmission line system, comprising an electron discharge device within said resonator adapted when energized to alter said natural frequency of oscillation of said resonator so as to block the flow of energy in said leg of said transmission line going to said load.

12. A cavity resonator comprising a substantially enclosed chamber having side and end walls including a reentrant portion formed of said end walls substantially at the center of said chamber, and a tuning element comprising an electron discharge device disposed therein so as to alter the natural frequency of said resonator.

13. A cavity resonator comprising a substantially enclosed chamber, coupling means for connecting said chamber with a source of radio frequency energy and with an output circuit respectively, means for periodically curtailing the flow of energy from said source to said circuit comprising an electron discharge device disposed within said chamber and means for alternately discharging said device so as to vary the impedance of said resonator with respect to said source and to halt the flow of energy thereto.

14. A cavity resonator comprising a plurality of side and end walls, a reentrant section formed of a portion of one of said end walls approaching one of said other end walls to form a constricted area therebetween, an electron discharge device disposed without said constricted area within said cavity resonator, and means for cyclically discharging said device so as to alternately detune said resonator.

15. A cavity resonator comprising a substantially enclosed chamber having side walls, end walls and a reentrant section bent from a portion of one of said end walls extending toward

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one of said other end walls to form a constricted passage therebetween, an outer enlarged passage surrounding said reentrant section being symmetrically disposed about the longitudinal axis of said reentrant section, an electron discharge tube disposed within said enlarged passageway and means cyclically exciting said gaseous discharge tube so as to recurrently detune said cavity resonator.

16. A high frequency transmission system comprising a source of energy, multiple loads for receiving said energy from said source, and switching means for controlling said energy delivered to said loads, said switching means comprising axially symmetrical reentrant cavity resonators, each having an electron discharge tube contained therein so as to tune said cavities.

17. A high frequency transmission system for electromagnetic energy comprising a source of high frequency energy, multiple high frequency loads, a network for interconnecting said source with said loads to transmit electromagnetic energy thereto, switching means in said network comprising an axially symmetrical reentrant resonant cavity having an electron discharge device disposed therein and means for cyclically exciting said device so as to periodically detune said resonant cavity and halt the flow of energy from said source to one of said loads.

18. An apparatus comprising an axially symmetrical reentrant cavity resonator adapted to have a predetermined natural frequency of oscillation, an electron discharge device disposed within said cavity of said resonator, and cyclical switching means connected therewith to energize said discharge device so as to alter the resonance of said resonant cavity periodically.

19. A high frequency apparatus comprising an enclosed hollow cavity having a reentrant section dividing said cavity into dissimilarly constricted areas, an electron discharge device disposed within the larger of said constricted areas and energy means cyclically connected with said electron discharge device to periodically activate said device so as to alter the frequency characteristics of said resonator.

20. A high frequency apparatus comprising an enclosed hollow cavity having a reentrant section dividing said cavity into dissimilarly constricted areas, an electron discharge device disposed within the larger of said constricted areas parallel with the longitudinal axis of said reentrant section, and energy means cyclically connected with said electron device to periodically activate said device so as to alter the frequency characteristics of said resonator.

21. A cavity resonator comprising a substantially enclosed chamber having side and end walls including a re-entrant portion formed of said end walls substantially at the center of said chamber, a rarefied gaseous atmosphere contained within said chamber, and electrodes immersed in said atmosphere adapted upon energization to ionize said atmosphere so as to alter the natural frequency of said chamber.

22. A cavity resonator comprising a substantially enclosed chamber having side and end walls including a re-entrant portion formed thereby, a gaseous atmosphere contained within said chamber, and spark gap means immersed in said atmosphere adapted upon energization to electrically charge said atmosphere so as to alter the natural frequency of said chamber.

23. A cavity resonator comprising a substantially enclosed chamber having side and end

walls including a re-entrant portion formed thereby, a gaseous atmosphere contained within said chamber and electrical elements contained within said atmosphere adapted to alter the state of said atmosphere so as to vary the resonant frequency of said chamber.

24. A cavity resonator comprising a substantially enclosed chamber having side and end walls including a re-entrant portion forming constricted sections in said chamber, a rarified gaseous atmosphere contained within said chamber and a plurality of electrodes immersed within said atmosphere and in one of said constricted portions, said electrodes being adapted upon energization to alter the electrical state of said atmosphere and to vary the natural frequency of said chamber.

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