

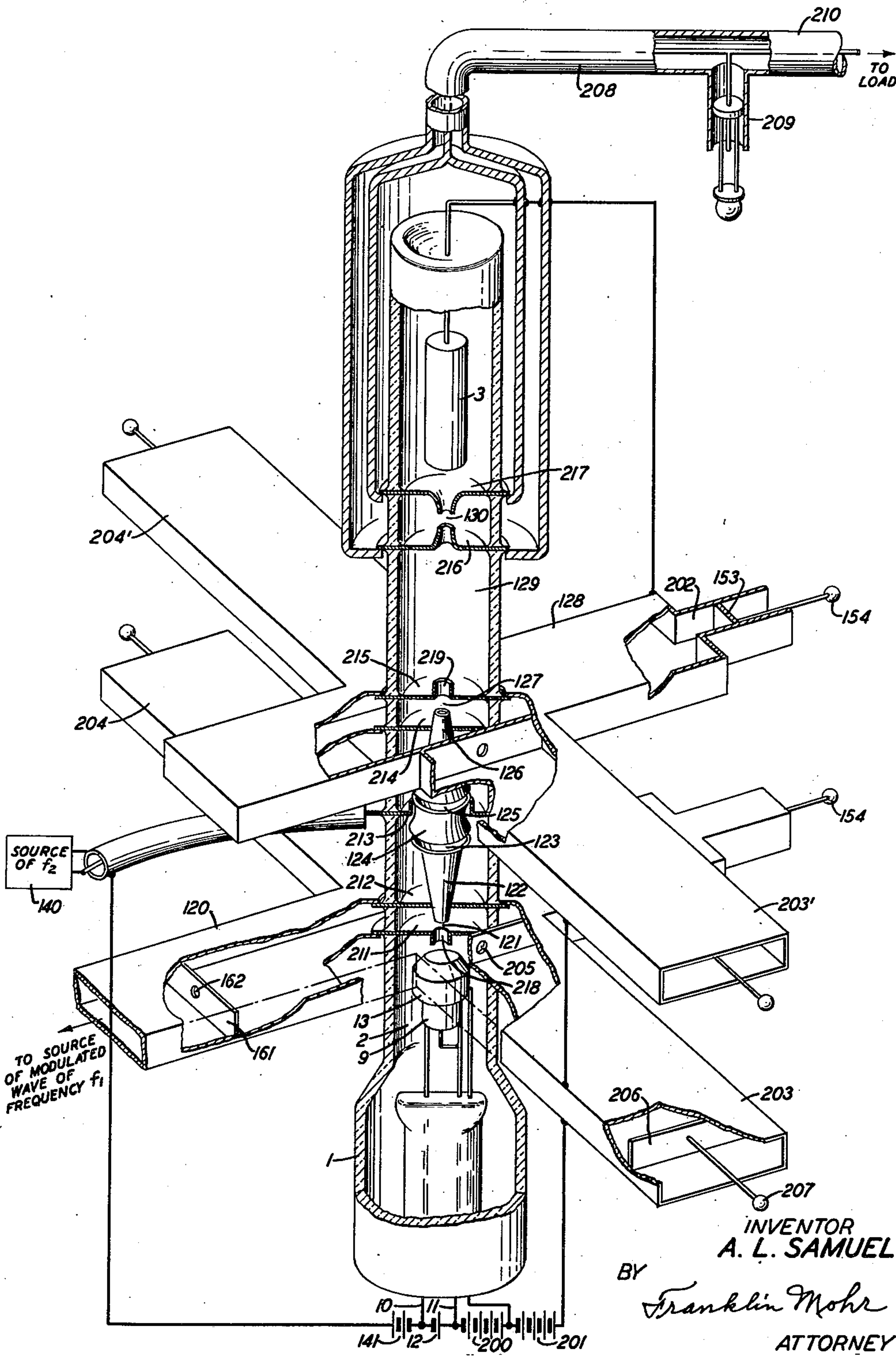
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TUNING ARRANGEMENT

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TUNING ARRANGEMENT

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1 Claim. (Cl. 178—44)

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This invention relates to electronic devices, particularly for operation at ultra-high frequencies.

An object of the invention is to facilitate the operation and tuning of amplifiers, oscillators and the like, especially those employing resonating chambers or cavity resonators.

A feature of the invention is a provision for a precise or fine adjustment of the tuning of a cavity resonator comprising an adjustable branch chamber of such restricted dimensions compared with the main cavity that the resonant frequency of the main cavity is close to and somewhat below the range of free transmission of electromagnetic waves in the branch cavity so that the latter will not fully support a wave of the frequency to be resonated and adjustment of the size or shape of the branch cavity will have a definite but relatively small effect upon the resonance of the arrangement as a whole.

Another feature of the invention is the provision of a plurality of loosely coupled branch cavities adjustable to resonate at the same frequency as the main cavity or at slightly different frequencies, producing in either case a broad frequency band or relatively flat transmission characteristic for the system.

This application includes subject-matter originally disclosed in my copending application, Serial No. 412,067, filed September 24, 1941, and is a division of my copending application, Serial No. 441,937, filed May 6, 1942.

Further objects and features of the invention will be apparent from the following detailed description and the accompanying drawing, while the scope of the invention is defined in the appended claim.

The single figure of the drawing represents an embodiment of the invention in a frequency conversion system employing resonating chambers or cavity resonators.

Referring to the drawing, an evacuated, insulating envelope 1 is represented as enclosing a plurality of elements including a suitable source of an electron stream such as an electron gun or beam projector shown generally at 2, and an electron intercepting electrode or collector 3. The electron gun 2 is provided with an electron emitting cathode 9 which may be associated with any suitable heating means energized, in the embodiment illustrated, through leads 10 and 11 by a source 12 of electromotive force. Associated with the cathode 9 there may be an electrode 13 for use in regulating and varying the current of the electron beam and commonly known as an accelerating electrode. It may be adjacent to and coaxial with the cathode.

A plurality of conductive discs 211 to 217, inclusive, are hermetically sealed into and through the envelope 1 in any known manner. The discs are spaced at suitable intervals along the path of

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the electron stream as hereinafter described, and each is provided with a central aperture in alignment with the axis of the electron gun 2 in order to accommodate the passage of the electron stream from said gun to the collector 3. A pair of adjacent discs 211 and 212, respectively, form parts of opposing walls of an input resonator 120. The disc 211 may have attached thereto a short tube 218 aligned with the aperture and extending outwardly with respect to the walls of the resonator 120. The disc 212 has fastened to the edge of the aperture therein a relatively long, flaring tube 122. Longitudinally of the path of the electron stream a gap 121 is defined between the central portion of the inner surface of the disc 211 and the small end of the tube 122. The disc 213 has fastened to the edge of the aperture therein a ring-shaped electrode 124 positioned adjacent to the large end of the tube 122. An annular gap 123 is defined between the adjacent ends of the tube 122 and the electrode 124. A pair of adjacent discs 214 and 215, respectively, form parts of opposing walls of an intermediate resonator 126. The disc 214 supports a flaring tube 126 similar to but inverted with respect to the tube 122 with the large end of the tube 126 defining together with the upper edge of the electrode 124 an annular gap 125. The disc 215 may have, attached to its outer side and surrounding the aperture, a short tube 219. A gap 127 is defined between the central portion of the inner surface of the disc 215 and the small end of the tube 126.

The walls of the resonator 120 should be conductive, or should at least have conductive inner surfaces. The tubes 122, 126, 218 and 219 and the ring 124 should be conductive and should be conductively fastened to their respective supporting discs.

The portion of the arrangement so far described is similar to one disclosed and claimed in my copending application, Serial No. 388,031, filed April 11, 1941, and assigned to the assignee of the present application. The resonator 120 may be connected with a suitable wave guide for supplying incoming waves to the resonant system, the guide being separated from the resonant chamber by a conductive partition 161. Coupling between the guide and the resonant chamber may be effected by means of a suitable aperture 162 in the partition 161. The wave guide may be formed as an extension of the walls of the resonator 120 as shown.

Separated from the gap 127 by a suitable drift space 129 is a gap 130 which is defined by opposed truncated conical portions of the discs 216 and 217. These discs form portions of the walls of a resonator, e. g., a quarter wave-length coaxial conductor system 208, which may have a tuning branch 209. A source 140 of alternat-

ing potentials is connected with the electrode 124, the direct potential of electrode 124 being maintained at a relatively low potential with respect to the cathode by a source 141, whereas the conductive portions of the resonators 120, 128 and 208 and the collector 3 are maintained at a relatively high positive potential with respect to the cathode by means of batteries 200 and 201. The electrode 13 may be connected, as shown, to the positive terminal of the battery 200. To effect the relative potential values hereinbefore specified the potential of the battery 141 may be relatively low with respect to the combined potential of batteries 200 and 201. The tuning branch 209 may serve to define the short-circuited end or voltage node of the quarter wavelength line 208, another branch 210 being provided for connection to any suitable load.

In the operation of the system shown in the drawing, the input wave, the carrier frequency of which will be designated f_1 and which wave may bear signals in the form of modulations, e. g., amplitude modulations, is resonated in the chamber 120 and produces an electron velocity variation in the electron stream as the latter traverses the associated gap 121. The frequency of the wave supplied by the local source 140 will be designated f_2 . Electron velocity sorting takes place within the tube 122 due to the influence of the relatively low potential of the electrode 124. With proper selection or adjustment of the battery potentials, a condition is readily secured in which the faster electrons pass through the space within the electrodes 124 and 126 whereas the slower electrons are deflected and intercepted by the electrodes 122, 124 and 126, the result being a charge density variation both in the stream of electrons which pass beyond the tube 126 and in the current intercepted by the electrodes. The degree of velocity sorting and resultant grouping produced is, however, in the present system, under the control of the local source 140 by virtue of the variable potential superimposed upon the direct current biasing potential of the electrode 124 which causes the resultant bias to fluctuate. Upon passing the gap 127, the density-varied electron stream serves to excite electromagnetic oscillations in the resonator 128, which resonator may be tuned to respond to one or both of the frequencies (f_1+f_2) and (f_1-f_2) , to reinforce these frequencies which, it will be noted, are modulation products separated from the frequency of resonator 120 by an amount equal to the value of the frequency of the source 140. Oscillations thus produced in resonator 128 impress a corresponding velocity variation upon the electron stream as the latter traverses the gap 127. The velocity variation of the electron stream entering the drift space 129 will contain a component of the local frequency f_2 of source 140 bearing the signal modulations of the original incoming wave of frequency f_1 . The velocity variation is converted in the drift space 129 into density variations at the gap 130 by the grouping effect of faster electrons overtaking slower electrons.

The resonant line 208 may be tuned by means of the adjustable branch 209 to the frequency f_2 of the source 140 and will be excited into forced oscillations by means of the density variations at the gap 130. The output of the line 208 may be led through the branch 210 to a suitable load such as an intermediate frequency amplifier or other utilization means.

In connection with the resonator 128 there is

shown a precise or fine tuning arrangement, comprising a branch cavity 202 of relatively small dimensions, shown broken open, in which is slidably mounted a piston 153 which may be moved by means of a suitably connected knob 154. A similar arrangement may be employed in connection with the resonator 120. The branch cavity 202 is preferably of such restricted dimensions compared with the main cavity that the resonant frequency of the main cavity is close to and somewhat below the range of free transmission of the branch cavity so that the latter will not fully support a wave of the frequency to be resonated. Then a relatively large motion of the piston 153 will produce only a relatively small change in the resonant frequency of the combination. The currents flowing in the branch cavity will be less than in the main cavity with the result that any losses associated with the sliding contacts between the piston 153 and the walls of the cavity 202 will be minimized.

The resonator 120 is provided with adjustable side cavities 203 and 204 for the purpose of enabling the resonator to respond to a relatively wide frequency band. The side cavity 203 is coupled to the main cavity by means of an aperture 205 and is adjustable by means of a piston 206 connected to a knob 207. The side cavity 204 is connected to the main cavity and adjustable in a similar manner. The resonator 128 may be similarly equipped. The aperture 205 is preferably of a suitable size to provide a loose coupling between the adjacent chambers. The side cavities may be independently adjusted to resonate at the same frequency as the associated main cavity or at slightly different frequencies, producing in either case a broad frequency band or relatively flat transmission characteristic in the well-known manner of coupled resonant circuits of whatever form.

In the operation of the system as above described the resonator 120 is assumed broadly tuned to the frequency f_1 of the incoming wave and responsive to the sidebands due to the modulation which the incoming wave may bear. The resonator 128 may be tuned broadly to (f_1+f_2) or (f_1-f_2) as desired, while the line 208 is tuned to f_2 . It is also feasible to operate by tuning the resonator 128 sharply to one of the above-mentioned frequencies. In that case, the side chambers 203' and 204' are not needed and the apertures for coupling the side chambers to the main cavity should be closed. It is also feasible to operate with the resonator 128 tuned so broadly as to include both (f_1+f_2) and (f_1-f_2) , in which case the line 208 may be energized at twice the frequency f_2 and the length of the line 208 up to the position of the tuning stub should be increased accordingly.

What is claimed is:

A tuning arrangement comprising a substantially closed system of resonating chambers containing a main chamber and a communicating branch chamber, said branch chamber being of restricted dimensions to determine for said branch chamber a cut-off frequency close to and somewhat above the resonant frequency of the main chamber, whereby a wave impressed upon said main chamber and substantially resonant therein is attenuated upon entering said branch chamber, and means for tuning said branch chamber to effect a fine tuning adjustment of the system as a whole.