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CAPACITIVELY COUPLED CAVITY RESONATOR

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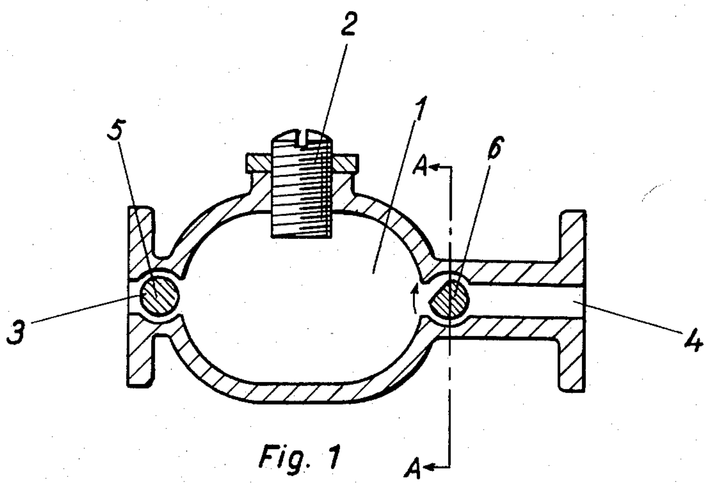

Fig. 1

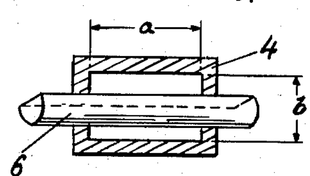

Fig. 1a

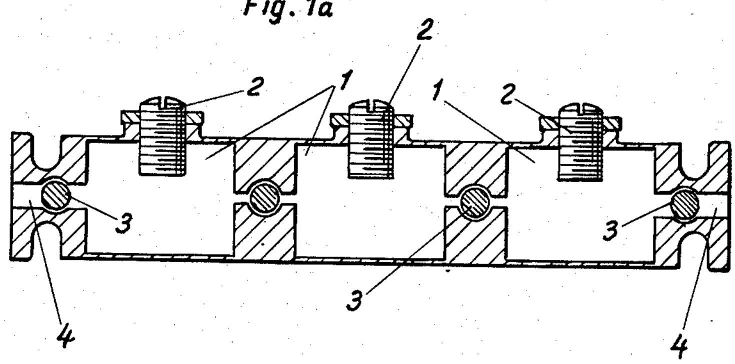

Fig. 2

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CAPACITIVELY COUPLED CAVITY RESONATOR

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4 Claims. (Cl. 333—73)

The invention relates to a cavity resonator, which is coupled capacitively, preferably with flat type rectangular waveguides.

It is known that within the range of the microwaves, resonator circuits or their combinations forming frequency filters, can be built up out of cavity resonators. By suitably selecting the dimensions, the tuning or adaptation and the coupling elements of such resonators among each other and with the connecting transmission line it is possible to obtain similar properties as with the filters composed of concentrated elements.

It is possible to realize four different kinds of coupling between nonresonant and resonant line sections, i.e. the capacitive (C) or inductive (L) coupling either with the resonator current (H) or with the resonator voltage (E). Relatively simple to realize are the combinations CE and LH, which are generally employed. However, they bear the disadvantage of getting a broader bandwidth at the tuning through with an increasing frequency and, in this way, result in unsymmetrical amplitude and delay characteristics versus frequency. In addition thereto, as is well-known, all line resonators have unwanted pass bands approximately at all integer multiples of the fundamental pass band. The combinations CE and LH become of a broader bandwidth as the octaves increase, so that they have a very poor harmonic suppression. It is regarded as a further disadvantage of these combinations that their equivalent circuit is arranged inside the resonator, which has an unfavorable effect with respect to branching circuits or when such a filter is connected to transmission lines of different characteristic impedance at input and output.

The remaining two combinations CH and LE do not have these disadvantages. With resonators of a smaller relative bandwidth, however, the LE type combination is practically difficult to realize, because large series inductances cannot be unambiguously represented with or in the case of microwaves. Also the CH type combination is encountered by similar difficulties, because diaphragm couplings of the conventional type with a sufficiently high susceptance are incapable of being governed with regard to the precision required. The application of the embodiment of a coupling capacity, which is customary with coaxial line resonators, by means of thick screw-stamps, in cavity resonators bears a further disadvantage, namely the excitation of higher $H_{n,0}$-waveforms and their disturbing consequence caused by the relatively long decay distance.

The invention, therefore, is aimed at reaching the advantages of a capacitive H-field coupling of cavity resonators preferably with rectangular waveguides by avoiding the aforementioned disadvantages.

In this respect it is proposed, in accordance with the invention, that the inside space of preferably a rectangular waveguide, that is connected to the cavity resonator, is terminated by a capacity which is arranged between the two broad side wall of the said waveguide, so that the spacial dimensions of this capacity substantially extend equally over the entire width of the waveguide, and so that the adjoining cavity resonator is coupled via this capacity by way of a current or H-coupling.

An advantageous further embodiment of the invention consists in that as a coupling capacity in the inside space of the waveguide there serves a conductive rod arranged in parallel with the broader side walls *a* thereof, and that between these side walls and the conductive rod there is respectively formed a slot-like coupling gap of the length *a*.

This can be accomplished by employing rectangular cavity resonators of a same width *a* and a same height *b* as the connecting or adjoining waveguide. It is particularly appropriate that its height *b* is greater than that of the coupled flat type rectangular waveguide, and that the resonator is excited in the H_{10n}-mode.

One possibile form of a resonator, in which the width *a* of the connecting waveguide is maintained, is the regular cylindrical H_{111}-resonator of the same cylinder height, which is being excited from a generating line.

Finally there has proved to be particularly favourable a modification of the two aforementioned types of resonators in such a way that the cavity has a cylindrical shape with an oval cross-section, that the rectangular waveguide is coupled along a generating line at the narrow-side of the cylinder, and that the resonator is excited in a degenerated H_{111} circular- or H_{101} rectangular-mode.

In order to achieve a particularly high coupling susceptance at which no disturbing H_{n0}-wave forms are excited, there is proposed a coupling which is so dimensioned that the conductive rod or bar has a circular cross-section and the inside space of the waveguide at the point of the coupling, is in such a way extended or enlarged by a corresponding boring in parallel with the side walls *a*, that the coupling gaps, which are formed by the conductive rod, have a segment-shaped cross-section.

A tunable coupling can be accomplished in that the circular cross-section of the conductive rod is flattened on one or two sides, so that the coupling gaps will have a width that may be varied by turning the cylinder.

It is another advantage of the invention that the coupling rod can be inserted from the outside. The bandwidth and the transmission ratio of the resonator can thus also be varied within wide limits in that the coupling rod is capable of being interchanged at will.

Capacitively coupled cavity resonators according to the invention are especially suited to the purpose of manufacturing frequency filters in that either corresponding previously balanced resonators, by the interconnection of waveguide pieces, are connected to form a lambda-quarter-coupled filter, or that cavity resonators, directly adjoining the coupling capacity, are combined to form a directly coupled multi-circuit filter.

In the following the invention will be described in particular with reference to some examples of embodiment shown in Figs. 1, 1*a*, and 2 of the accompany drawing:

Fig. 1, in a longitudinal section, shows a cavity resonator **1** with a tuning stamp **2** and the connected rectangular waveguides **3** and **4**. In this example the cavity is designed as an oval H_{111}-resonator. This shape has proved to be particularly flavourable for both the manufacture of the casting and the necessary surface processing.

The reference numerals **5** and **6** in the drawing denote the coupling rods, which according to the invention, are arranged freely in respectively each a boring that somewhat expands the waveguide. The rod or bar **6** is somewhat flattened on one side, so that, by turning it within the boring, the width of the gap can be varied at least on one side within certain limits.

With a resonator of the shape or type as shown in Fig. 1 of the drawings there can be obtained, within the 4000 mc. range, bandwidths between 10 and 100 mc. and more at only the slightest natural attenuation, permitting already without changing the position of the coupling rods to tune the resonance frequency with an almost constant bandwidth throughout a range of 600 mc. and even more. When flanging several such resonators with a corresponding distance (about one quarter of a wavelength between the coupling cylinders) behind each other then it will be possible to set up from individual or single resonators, which are tuned correspondingly in the most simple manner, a multi-circuit filter possessing properties that can be varied at will within wide limits.

Figure 1*a* illustrates a sectional view taken along lines A—A of Fig. 1. This figure illustrates the position of coupling rods **6** in rectangular waveguide **4**. Letters *a* and *b* represent the width and height respectively of waveguide **4**.

In a similar way there may be built up a multi-cavity filter from a number of resonators, which are directly coupled with one another, as is shown in Fig. 2 in the form of a three-section filter, wherein **1** denotes the three cavities of the same type, which are designed in this example as H_{101}-rectangular resonators. Reference numeral **2** indicates the tuning screws (also termed screw stamps or tuning stamps hereinbefore), **3** the coupling cylinders (or rods) which, if so required, may have different diameters, and **4** the connecting waveguides. Also a filter of this type is widely tunable without any noteworthy change of the bandwidth and of the transmission properties. It further bears the added advantage of having a substantially frequency-independent length, because between the individual cavity resonators there are arranged no line sections or pieces, the length of which would have to be tuned or matched.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. An arrangement for coupling the rectangular waveguide, having walls of major and minor dimensions to a cavity resonator, having apertures therein substantially equal to the major dimension of said waveguide comprising means for connecting the walls of said waveguide to said resonator about said aperture, and a rod extending across the entire width of said waveguide across its major dimension adjacent said aperture.

2. An arrangement according to claim 1, wherein said means comprises extensions of said waveguide walls of said major dimensions enlarged with respect to the normal wall, said rod being mounted in said enlarged region.

3. An arrangement as in claim 1, wherein said rod has a non-symmetrical cross-section.

4. An arrangement as in claim 1, wherein said rod has a circular cross-section having one of its sides flattened so that the capacity of the coupling between said resonator and said waveguide can be varied by turning the rod.

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