1. Introduction

It is important to calculate the relationship of the elements of a cylindrical generator to determine the electrodynamic characteristics. In particular, the issue of determining the geometric dimensions of the coupling hole in the local oscillator for a cylindrical resonator with a coaxial waveguide chamber orthogonally placed on their axes is important.

Calculation of the loaded Q factor can’t be performed without determining the shape and size of the communication hole between the resonator and the coaxial diode chamber of the generator.

2. Methods

The projection method is used for two connected hollow cylindrical structures – a coaxial waveguide and a cylindrical resonator (Fig. 1).

Their radii are respectively equal to r and R, t is the distance between the axes. The shape of the intersection shape in most cases is determined when constructing the studied intersection of the shapes according to the rules of descriptive geometry.

When considering projections of the system on planes that are parallel to the axes, it can be assumed that the curved figure defining the communication hole is an ellipse. It is also possible to assume that it is approaching a flat ellipse with diameters: a – larger, Smaller. In Fig. 1, this figure has projections on planes in a rectangular coordinate system in the form of segments with chords a and b and with heights h and k.

Let’s accept the condition that the radii of the waveguides R and r in the region of the communication hole do not differ from the values in the regular part of the waveguides and (R+r)t.

According to Fig. 1 the magnitude of the larger diameter of the ellipse a is determined from the expression:

\[ a = 2\sqrt{2hr - h^2}, \]  

where h is the height of the segment. Since the distance between the axes is \( t = (R+r)-h \), let’s obtain:

\[ a = 2\sqrt{2hr - h^2}, \]  

where

\[ b = 2\sqrt{2kr - k^2}, \]  

so

\[ b = 2\sqrt{R^2 - (t-R)^2}. \]  

The area of the communication hole, subject to the planarity of the ellipse, is:

\[ S = \pi \sqrt{ab} = 4\pi \sqrt{\left(\frac{r^2 - (t-R)^2}{R^2 - (t-r)^2}\right)} \]

Provided that

\[ t = R + r, \]  

\[ S = 0. \]

3. Results

In a real circuit for a generator: \( R=6.4 \) mm and \( r=2.0 \) mm. Table 1 shows the dependence of the radii a and b on the distance between the axes t.

In accordance with the Table 1, the dependences of the ellipse radii a and b on the distance between the axes t are shown in Fig. 2, 3.

As can be seen from the Table 1, the diameters a and b behave similarly when t changes. The larger the ellipse radii, the smaller the distance between the axes of the cylindrical structures.
elements. When conducting a numerical analysis, when the coordinate function system characterizing the field distribution at the hole is constructed based on the solution of the membrane equation (under the boundary conditions of equality of the electric field along the hole contour), difficulties arise. Therefore, given the complexity of the hole contour, with some approximation, it is possible to replace the elliptical contour with an equivalent rectangular one.

| t, mm | a, mm | b, mm |
|-------|-------|-------|
| 8.3   | 2.24  | 1.25  |
| 8.0   | 4.44  | 2.40  |
| 7.0   | 7.98  | 3.80  |
| 6.8   | 8.46  | 3.98  |
| 6.4   | 9.29  | 4.07  |

Fig. 2. The dependence of radius $a$ on the distance between the axes $t$

Fig. 3. The dependence of radius $b$ on the distance between the axes $t$

With this change (as $t$ changes), it is convenient to consider the gap width to be variable. The area of the ellipse is equal to $S = \pi ab$, and the area of the rectangular slit is $S = mn$. If choose a slit width equal to the small diameter of the ellipse ($a=m$), then the length of the slit ($b=n$) changes insignificantly when $t$ changes. This is convenient when choosing a system of coordinate functions characterizing the distribution of the field at the communication hole.

The results of these calculations in the form of the dependences of the dimensions of the rectangular slit on the distance between the resonator axes and the coaxial camera for this generator are given in Table 2 and in Fig. 4.

Table 2

| t, mm | n, mm | m, mm |
|-------|-------|-------|
| 8.3   | 1.25  | 4.2   |
| 8     | 2.4   | 4.27  |
| 7     | 3.8   | 4.53  |
| 6.8   | 3.9   | 4.57  |
| 6.4   | 4     | 4.48  |

Fig. 4. Dependence of the height of the equivalent rectangular gap on the distance between the axes of the ellipse

The shape and magnitude of the bond in a small-sized local oscillator are determined for the intersection of two unequal radii of cylindrical volumes with axes orthogonally located relative to each other at a distance.

4. Discussion and conclusions

The results can be applied in calculating the coupling between the coaxial diode section and the cylindrical resonator to determine the stability of the generation. Results are only for given values of $R=6.4$ mm and $r=2.0$ mm. They are also important for determining the loaded $Q$-factor of a stabilizing cavity resonator in a generator. In the future, it is possible to verify the results experimentally for a small local oscillator.

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