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Flexible guides for high power signal.

In a flexible waveguide system a layer of a high thermal capacity fluid, e.g. mineral oil, FCT (2) is maintained in contact with the waveguide. A refrigerating liquid FR (8) can be associated to said fluid FCT (2).

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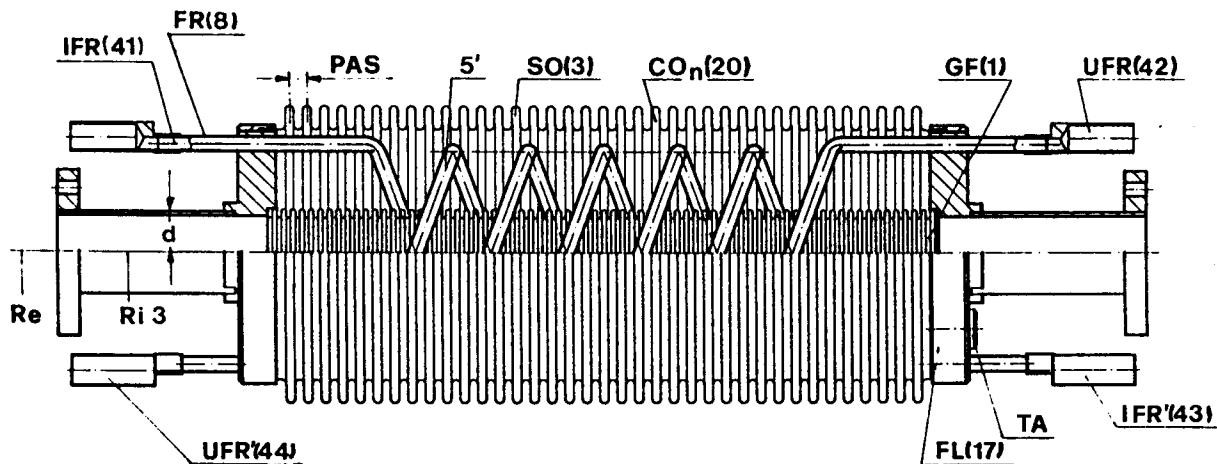


Fig. 3

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The present invention concerns flexible wave guides to transmit high power signals, consisting substantially of corrugated tube pieces or sections with thin walls, and of flanges and connectors at the ends of said tubular elements.

Several flexible wave guides types are known and widely used.

In one of their most common structures said flexible wave guides are formed of thin wall corrugated tubes (thickness of from one to two tenths of millimeter). When said guides are run through by high power microwave signals (of the order of from few tens to some hundreds of KW) the problem of their cooling is to be faced, which, at a first approach, could be solved by applying cooling fins; because of the flexible wave guide thin thickness wall the welding of the fins to the guide body is difficult due to differences of thickness between fins and the guide and to the poor mechanical resistance of the flexible guide which should support the heavy fins as well as because of the overheating of the flexible tube portion between one section and the successive one caused by the thin wall high thermal resistance.

For high peak powers, the dissipated power in the flexible guide during a pulse must be stored in the flexible guide small mass before flowing to the fins; the poor thermal capacity generates therefore very high overtemperatures which could even melt said flexible body.

For very high powers the water cooling (generally used for the not-flexible guides) cannot be adopted as the soldering of a cooling tube would affect the flexible guide flexibility.

Object of the present invention is that of providing a flexible guide system which does not show the above mentioned drawbacks, is easy to be brought about and ensures a great efficiency in the heat dispersion.

This and other objects are reached with the system according to the invention, which is substantially characterised in that a high thermal capacity fluid is associated to the flexible wave guide.

In a very simple and efficient embodiment the flexible guide is contained in a sleeve, sheat, jacket or, preferably, in a bellows, said bellows being metallic and filled preferably with a not-moving mineral oil.

According to an other remarkable feature of the invention, to the stationary oil mass is, on its turn, associated a moving cooling fluid which accelerates the remotion of the therein accumulated heat.

In an other particularly simple and efficient embodiment, at least one coil run through by a cooling medium, f.i. water and provided of forced inlet and outlet means passes through said oil mass.

Other not less peculiar characteristics of the

invention can be learned from the claims at the end of this specification.

The various features and advantages of the invention will better appear from the following description of a general scheme and of some emblematic (but not limitative) embodiments shown in the accompanying drawings in which:

- figure 1 is a schematic cross-sectional view of the system according to the invention, in its generality;
- figures 2 and 3 are schematic front views of two embodiments of a sleeve or jacket, and
- figure 3A is a cross-sectional view of fig.3.

In fig. 1 the system includes, together with the flexible wave guide GF(1) a high thermal capacity fluid FCT(2), an envelope or housing IN(3) to keep said fluid around the guide, and a fluid tank SF(4) with relevant faucetor tap R(5), said tank acting also as expansion vessel to compensate the volume variations originating from the guide flexibility. According to a further feature of the invention, means MI-MI'-M2-M2'(6,7) are provided for the circulation in the fluid FCT(2) of a refrigerating fluid FR(8) coming f.i. from one or more sources SO(10) and collected in one or more possible containers SR(9) from which it is possibly recycled to SO(10) through possible recycling conduits RFR(8). Preferably the high thermal capacity fluid FCT(2) is kept associated to the wave guide GF(1) in stationary conditions. On the contrary, when to said fluid FCT(2) is associated the refrigerating fluid FR(8), this last medium is circulated at the most appropriate speeds and flow rates through conduits MI-(6)-M2(7)-MI(17) possibly forced by pumps PO-PO'. These last means as well as the sources SO-(10), the collecting containers SR(9) and the circulation conduits RFR(3) are in general substituted by the centralized pump and by the cooling liquid (f.i. water) circuits already present in the general system associated to the wave guide and to the articles and (nuclear) materials to be treated.

A very simple but efficient embodiment of the invention is shown in figures 2, 3 and 3A.

The flexible wave guide section GF(1) is conventionally fixed to two ends of the internal portion (showing a minor diameter) 15 of a supporting or landing flange FL(17).

To the outer portion (with a major diameter) 16 of said flange FL(17) is mounted the end 18 of a container of fluid FCT(2) having preferably the structure of sleeve SO(3). This last consists of a body (3) having a diameter $D_i(3)$ and of n corrugations $CO_n(20)$ showing an outer diameter De (radius Re) and pitch PAS .

The flexible wave guide GF(1) is normally of a conventional type i.e. with a body (4) formed of corrugating portions in copper or copper alloy (beryllium, phosphor, etc.) and does not require fur-

ther descriptive details.

In the figures 2, 3 and 3A are indicated with FL(32) the end flange of Gf(1), with CRG(3) the rigid end portion of GF(1), with TE(35) a possible frame supporting the system formed by GF(1)-+ SO(3); with TA(36) the filling corks of sleeve SO(3); and with 40 the connector of GF(1) to the other circuit components (not shown) which generate and feed the high power microwaves.

In the figures 3 and 3A is shown the system of fig.2 completed by the means MI(6) M2(7) (fig.1) associating the refrigerating fluid FR(8) to the high thermal capacity fluid FCT(2). In the case shown said means MI(6), M2(7), etc. are constituted of at least a pipe coil 5 with inlet IFR(41) and outlet UFR(42) of fluid FR(8). Also a second pipe coil 5 is preferably used with inlet from IFR' (43) and outlet UFR' (44); obviously inlets and outlets can be inverted.

As it can be seen from fig. 3A each coil 5 respectively 5' comprises f.i. a sleeve M5(M'5) within which runs the tube T5(T'5) circulating the refrigerating fluid FR(8). The holding holes of flange FL(17) are indicated by the reference FO.

In the most frequent application forms (f.i. in the experimental plants of nuclear fusion) in which the peak power (PP) can be above 1.5MW and the mean power above 200KW, with pulse duration of f.i. 20 seconds and intervals of f.i. 600 seconds, with signal frequency of f.i. 3,7 GHz and with flexible wave guides made of tempered copper with beryllium or of phosphorous bronze of standard type, optimal results have been obtained with the aid of stainless steel sleeves with wall thickness of about 0.2mm, outer diameter De (corrugated portions) of about 137-138mm, inner diameter (body 4) of about 135-126, corrugating portion pitch of about 9,3.

The standard wave guide GF1 had preferably rectangular cross-section of outer dimensions of f.i. 81.5x40.5 and inner size of 73x32.3mm.

When (as in the nuclear fusion) the peak power (PP) are of the megawatt order (f.i. from 700 to 1.5MW) but the mean power (PM) is not high f.i. is not above 100KW (around 50MW) the necessity of using pipe coils does not appear.

The volume of mineral oil (f.i. ESSO Somentor 43 oil having low viscosity but high boiling temperature above 100 °C) was of the order of 3 liters (for a wave guide length of about 3 dcm).

On the contrary with PP of the megawatt order and high PM, f.i. of the order of 180KW, at least a pipe coil was critically used having a diameter of about 7mm and a pitch of about 7cm.

Indeed to maintain a good elasticity of the flexible guide, the coil pitch must not go above this value.

The coils were of copper without oxygen to

avoid foulings. The refrigerating fluid was preferably demineralized water and the circulation speed was of about 20 liter/minute. The system centralized pump was used for this circulation.

The invention has been described with reference to the embodiments shown in the drawings which are however susceptible of variants, modifications changes etc. which fall within the spirit of the invention.

F.i. in certain cases the pipe coil can take the form of sheath, sleeve, even not metallic or be substituted by a tube bundle.

Claims

1. System of flexible wave guide to transmit microwave signals of high powers, substantially comprising sections of corrugated highly conductive (copper or copper alloys) tubes with thin walls, as well as flanges and connectors at the ends of said elements or tubular pieces, characterized in that a high thermal capacity fluid is associated to the wave guide.
2. System according to claim 1, characterized in that said fluid is mineral oil and is maintained stationary around and in contact with the guide outer surface by a container body which is also flexible and attached to at least a flange of same guide.
3. System according to claim 2, characterized in that said container is a corrugated metallic bellows.
4. System according to claim 3, characterized in that for peak power of from about 500KW to about 1,5 megawatt, transmitted with pulsed of about 15-25 second duration and at intervals of about 500-700 seconds, the metallic bellows is of stainless steel, has wall diameter of from 0.1 to 0.5mm, corrugated portion outer diameter of about 120-140mm, corrugated portion pitch of from about 7 to about 12 and contains an oil volume from 1 to 5 liters.
5. System according to claim 1 or 4, characterized in that to the high thermal capacity fluid is associated a refrigerating fluid kept in movement to remove the heat accumulated in the oil mass.
6. System according to claim 5, characterized in that it comprises at least a pipe coil flown by the refrigerating fluid.
7. System according to claim 6, characterized in that the oil mass is run through by two pipe

coils flown by water, the fluid flows having opposite directions.

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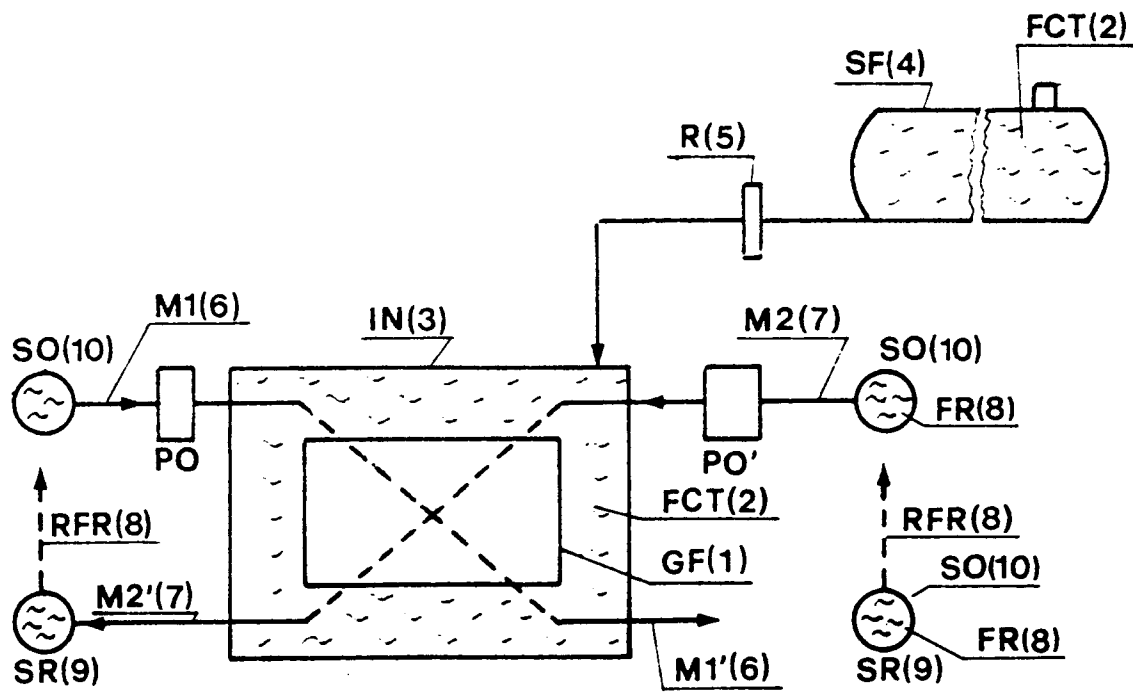
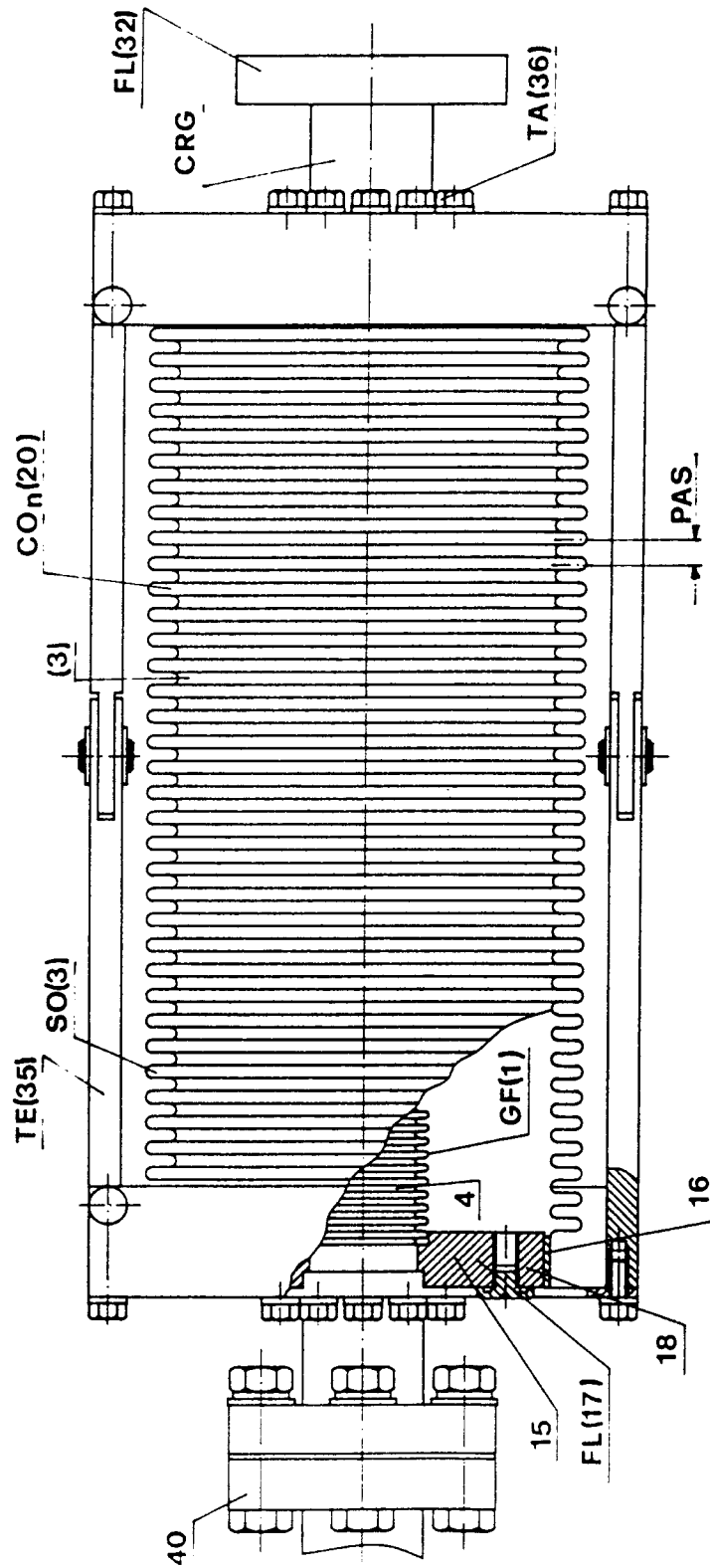


Fig.1

Fig.2





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	SOVIET PATENTS ABSTRACTS Section EI, Week 43, 7 December 1983 Derwent Publications Ltd., London, GB; Class V, AN 800365/43 & SU-A-985 858 (BELENKII) 4 January 1983 * abstract *	1-3, 5, 6	H01P3/14
A	GB-A-695 166 (BIRD ELECTRONIC CORP) * page 3, line 52 - line 57; figure 1 *	2	
X	FR-A-1 502 096 (CSF-COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL) * page 1, right column, line 12 - line 23; figure 1 *	1	
A	---	2,3	
A	GB-A-1 025 883 (ASSOCIATED ELECTRICAL INDUSTRIES LTD) * the whole document *	1,7	
A	FR-A-2 528 240 (THOMSON-CSF) * page 3, line 6 - line 20; claim 7; figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01P
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 01 SEPTEMBER 1992	Examiner DEN OTTER A.M.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			