United States Patent

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[54] **SOLDERLESS GAS SEALED WAVEGUIDE CONNECTOR**
12 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... 333/95 A, 333/98, 285/368;DIG. 4
[51] **Int. Cl.** H01p 1/04, H01p 3/14, F16l 73/00
[50] **Field of Search** ..... 333/95 A, 98, 98 P, 95; 285/368, 400, 412—414, DIG. 4

[56] **References Cited**

UNITED STATES PATENTS

Re.23,137	7/1949	Hobbs	285/368 X
3,030,253	4/1962	St John et al.	285/368
3,090,019	5/1963	Johnson et al.	333/95 (A)
3,315,184	4/1967	Wood	333/95
3,336,543	8/1967	Johnson et al.	333/95
3,374,450	3/1968	Stewart	333/98
3,461,409	8/1969	Miller	333/98

FOREIGN PATENTS

1,165,121	3/1964	Germany	333/95 (A)

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ABSTRACT: In this solderless waveguide connector a clamp, formed by two complementary half-ring sections, defines a passage which collars the end portion of a section of elliptical waveguide; the waveguide being of the type which contains ridges which extend across the width and sides of the waveguide. The end of the waveguide section is formed at the middle of one such transverse ridge. A recessed seat or rim about the passage in the front face of the clamp abuts and seats the outer surface of a portion of a transverse ridge. A waveguide transition section with a microwave passage therethrough includes a protruding lip portion which surrounds the microwave passage. The transition is fastened to the clamp so that the protruding lip engages the inner surface of the aforementioned ridge portion of the waveguide so that the waveguide at its end is firmly clamped between the clamping means and the waveguide transition. A cap having a hollowed-out portion and an aperture or waveguide passage through its rear wall fits over the waveguide, is fastened at its front end to the waveguide transition, and within the hollow encloses the clamp. A first O-ring seal located inside and toward the rear of the cap tightly abuts each of the surfaces of the cap, the waveguide, and the back surface of the clamp. A second O-ring seal surrounds an outer rim surface of the transition section and abuts both the transition section and a front inner rim surface of the cap.

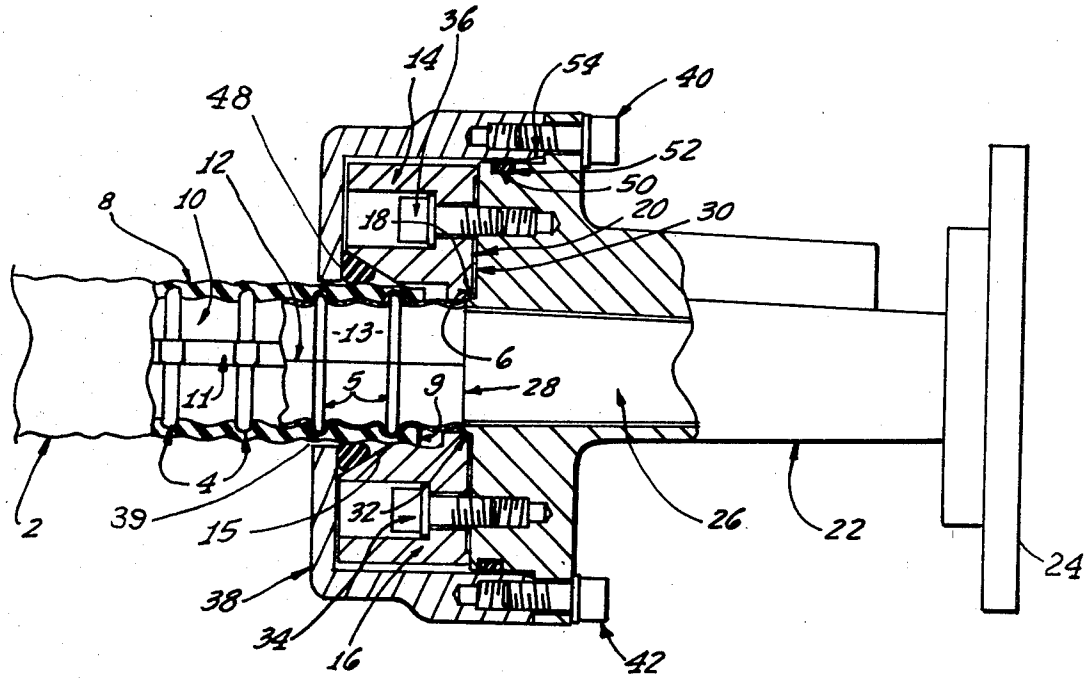


Fig. 1

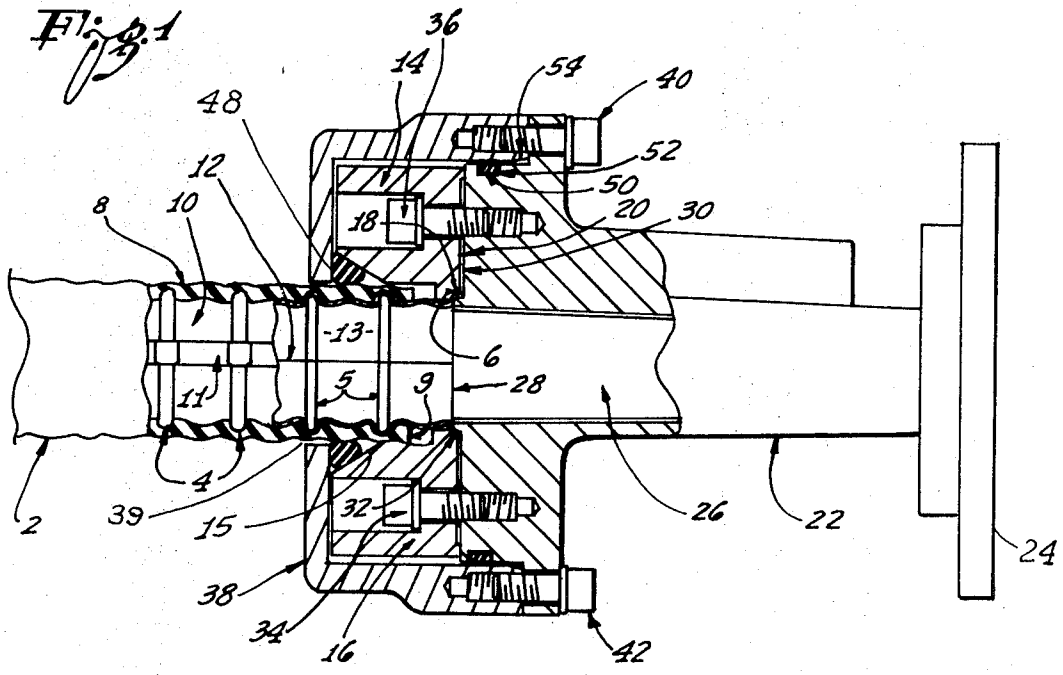
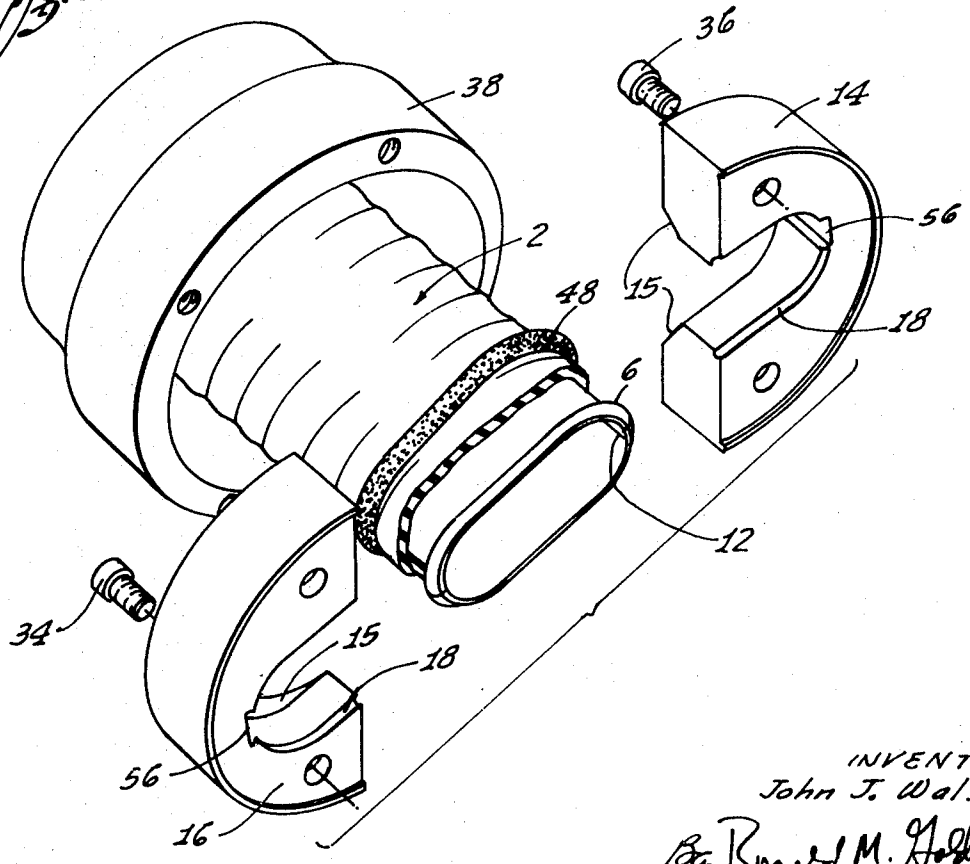


Fig. 2



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SOLDERLESS GAS SEALED WAVEGUIDE CONNECTOR

This invention relates to an improvement in waveguide connectors, and more particularly, to wave guide connecting means for uniting a waveguide connector to elliptical waveguide without the use of solder.

High frequency or microwave communication and signaling systems use a transmission line for propagation of microwave signals, commonly termed waveguide, to pass the signal from one point to another. The waveguide forms a conduit which, as examples, may be of rectangular or elliptical cross-sectional shapes. In these systems various lengths of waveguide, termed waveguide sections, are joined to one another by means of waveguide connectors, more particularly referred to as choke flanges, to form the complete transmission line. The choke flanges are well known and described in the literature and include a half wavelength choke section to prevent RF leakage at the connection. A flange is customarily united to, fastened or attached to each end of a waveguide section, conventionally, with solder. The solder permanently joins together the flange and the waveguide and provides a gastight seal.

Conventionally the inner conduits of the waveguide in waveguide systems are maintained in pressurized inert gas atmosphere in order to eliminate variations in the electrical transmission characteristics of the waveguide system otherwise caused by changes in atmospheric conditions. The requirement that the connector attachment be gastight is thus of no small importance.

Those manufacturing processes of attaching flange to the waveguide section which use soldering techniques must be performed, generally, in the factory where the necessary equipment is available. However, many microwave communication facilities are installed in remote locations. Although the waveguide "plumbing" used in such a facility is preassembled to desired lengths it is not atypical that in actual construction miscalculations occur or changes may be necessary which render the waveguide sections provided either too long or too short or of inappropriate shape to fit together as originally planned. Accordingly, experience has shown that where variations in construction are permitted such systems are constructed with increased efficiency if the installer can in the field cut to length and form a waveguide section, complete with connectors, to meet the requirements of the system.

Moreover, in use waveguide sections can be damaged to the extent that their transmission characteristics are no longer acceptable; this damage can occur by denting, cutting, or crushing. Spare parts are thus required. However, because of the unusual lengths and shapes of microwave sections found in these communication systems and the necessity of maintaining spare waveguide sections to replace any installed sections creates both a logistics and a storage problem. With flexible waveguide, and more particularly, elliptical flexible waveguide, the spare part problem is to a great extent eliminated since as the need arises the desired length of waveguide is in the field unreeled from a reel of waveguide, cut to length, attached to the connectors and installed. Thus any waveguide union or connector by which the field technician can assemble together the waveguide and connectors in the field without the use of solder, special equipment, or special tools is of great usefulness.

In the past, various types of connectors have been proposed which can be attached to the waveguide without the use of solder and which, at the same time, provide a gastight seal. While those proposals provide acceptable results, it appears that they are unduly complex, involve higher than necessary manufacturing costs, and require manufacturing and assembly operations which are best eliminated.

Accordingly, it is an object of this invention to provide a solderless waveguide union or connector;

It is another object of the invention to provide a solderless waveguide connector which can maintain a gastight seal;

It is a still further object of the invention to provide a solderless microwave connector which is simple in construction,

easy to install, and which eliminates any unnecessary cutting of the waveguide and special tooling; and

It is a still further object of the invention to provide a solderless waveguide connector which does not introduce any substantial discontinuity into the microwave path and which does not permit leakage of pressurized gas from the waveguide to the ambient.

Briefly stated, a solderless waveguide connector attachment or union in which a waveguide connector, flange, or transition is joined to the end of a length of flexible elliptical waveguide of the type having ridges transverse the width and height of the waveguide in a gastight solderless seal. Preliminary to the formation of this union the section of waveguide is severed from the remaining supply and the section end is formed by cutting along a protruding ridge so that, essentially, a ridge portion remains and provides, with respect to the waveguide, a flared end portion. Two half-ring sections together collar the end portion of a section of ridged elliptical waveguide and clamp the waveguide ridge portion between the clamp and an adjacent waveguide transition section. A cap which has a hollowed-out portion and an opening is mounted about the waveguide and in the hollowed-out portion encloses the clamp. The cap is fastened at its open end to the waveguide transition section. A first O-ring seal is located inside and at the rear of the cap. This seal tightly abuts each of the surfaces of the cap, the waveguide, and the back surface of the clamp. A second O-ring seal surrounds the outer rim surface of the transition section and abuts both the transition section and a front inner rim surface of the cap. The aforecited advantages of the invention together with its construction, mode of assembly, and operation are better understood by a thoughtful consideration of the following detailed description taken together with the figures of the drawing, in which;

FIG. 1 illustrates in cutaway a cross section of an embodiment of my invention; and

FIG. 2 illustrates in an exploded perspective view some elements of the embodiment of FIG. 1 and depicts their relationship to one another. The cutaway cross section of FIG. 1 shows the end portion of a section of waveguide 2. The waveguide is covered with a jacket 8, suitably neoprene, which covers the conventional thin electrically conductive metal 10, suitably copper. This waveguide has a generally elliptical-shaped cross section which may be visualized more readily by making brief reference to the corresponding element in the exploded view of FIG. 2. The waveguide has formed in the metal protrusions or ridges 4, 5 and 6 that are spaced apart along the waveguide. Ridges 4 are illustrative of their appearance on the outer surface of the metal waveguide 10 with jacket 8 cut away, and ridges 5 are illustrative of their appearance within the waveguide 10 with the metal of the waveguide wall cut away to show the cross section of the union. Ridge 6 is shown with a portion, approximately one half, cut off and provides a flared or protruding lip or rim end for waveguide section 2. Each of the ridges extend across the width and height of the waveguide and thus extend around the periphery of the waveguide The ridges form elliptical loops around the waveguide in a direction normal to the length of the waveguide. That continuity is interrupted by a seam which extends longitudinally along the sides of the waveguide and is illustrated as 11 along the outer surface and as 12 along the inner surface. Waveguide of this type is manufactured in accordance with a process such as disclosed in U.S. Pat. No. 2,840,897 by which the waveguide is manufactured in halves that nest together and are soldered together at the seam to form the closed conduit passage 13 of the waveguide. Waveguide of this type of construction is sold by and may be obtained from the Airtron Division of Litton Industries. The waveguide section is prepared for use in the connector with a cut along a ridge, such as half ridge 6, so as to leave remaining essentially one-half of the ridge which presents the flared end portion or lip of the waveguide section. The preparation of the elliptical waveguide in this manner is conveniently accomplished with two relatively simple tools: a hacksaw and a miter

box. Suitably, neoprene jacket 8 is cut off a short distance back from the waveguide end as at 9 and bares the metal 10 at the waveguide ridge 6.

Surrounding the end portion of the waveguide is a clamp which is formed of two complementary half-ring sections 14 and 16. In the cross section of FIG. 1 each of the clamp halves 14 and 16 are half removed. Sections 14 and 16 are placed about the waveguide end and ensleeve or collar, as variously termed, the waveguide end portion. Again, for ease of visualization of this relationship reference may be made to the correspondingly numbered parts in FIG. 2 Each half 14 and 16 of the clamp contains a chamfered or recessed rim portion 18 which extends about the waveguide and a front face portion 20. The rim is recessed from the face 20 and may preferably be shaped to fit flush with the outer surface of the half ridge 6. The recessed rim abuts or seats waveguide 2 at ridge 6. A flare or taper 15 is provided at the rear of clamp halves 14 and 16.

A waveguide transition section 22 is partially cut away in FIG. 1. A transition, as is conventional, couples microwave energy from elliptical waveguide to rectangular waveguide. The transition includes a conventional end flange 24 which is connected to a complementary flange attached to some other piece of waveguide to make the connection. It is useful to note that the portion of the connector which contains flange 24 and the microwave transition section 22 can be generically termed as a microwave flange means since, basically, that component of the invention incorporates the flange necessary to couple or connect the waveguide section to the flange of another waveguide section while the function for converting the elliptical waveguide input to a rectangular waveguide output by means of the transition is a function independent of the present invention. The flange, however, is a necessity to the formation of any connector. Thus a waveguide flange means in the preferred embodiment contains both a flange and a transition section. Internally the transition used in this invention is of conventional structure and function. Transition 22 includes a microwave passage 26 which has the same dimensions at its end 28 as the corresponding dimensions of wave guide 2, so as to provide, substantially, a smooth transition between the waveguide and the microwave transition section. Surrounding passage 26 and extending from the face 30 of the transition section is a protruding lip or rim portion 32. The outer dimensions of lip 32 is formed preferably so as to correspond to the shape and dimensions of the inner surface of the half ridge portion 6 of the waveguide section. Clamp halves 14 and 16 are each coupled or fastened to transition 22 by means of two bolts 34 and 36, respectively, only one of which is illustrated for each clamp half so that two bolts fasten each half ring section to transition section 22. As is apparent, the pressure exerted by the bolts sandwiches and clamps the waveguide ridge 6 between the protruding lip 32 of transition 22 and the recessed rim 18 formed in the sections 14 and 16 forming the clamp.

The cap 38 is in the form of a hollow cylindrical body closed at its rear (or top, as may be variously termed) end having an aperture or passage 39 therethrough. The cap fits over the waveguide 2 with the front edge of cap 38 fastened to the transition section by two bolts 40 and 42. As is apparent additional bolts may be provided. Passage 39 of cap 38 is slightly larger in dimension than the waveguide section taken at a ridge 4. An O-ring seal 48 surrounds waveguide 2 and abuts jacket 8 as well as the tapered surface 15 of the clamp sections and rear of cap 38. This provides a gastight seal between waveguide 2 and cap 38. A second O-ring seal 50 is seated in a groove 52 located along a rim surface 54 of transition 22. O-ring seal 50 abuts the inner rim 54 surface at the front end portion of cap 38 and groove 52 of the transition to form therebetween a gastight seal.

The exploded perspective view of FIG. 2 shows most of the elements, except for transition 22, and permits a better understanding of the elements comprising the invention and their relationship to one another. In FIG. 2 the elements which correspond to elements illustrated in FIG. 1 are similarly numbered. Thus, elliptical waveguide 2 is collared by two complementary half-ring sections 14 and 16 which together form a clamp. The clamp contains a recessed rim 18 extending around each half section which abuts and seats the half of ridge 6 at the end of waveguide section 2. An exception is a cutaway portion 56 to provide clearance for seam 12 in the waveguide, necessitated by the particular waveguide used in this embodiment. Cap 38 is displaced rearwardly from its assembled portion. For purposes of clarity the transition section 22 with protruding lip 32 is omitted from this figure since its cooperation with the clamp and its structure have been adequately treated in the description accompanying FIG. 1. O-ring seal 48 is displaced rearwardly, is fitted onto waveguide 2, and in its assembled position abuts the flared surface 15 of the clamp sections and the rear wall of cap 38.

As previously described the waveguide section is prepared by severing the waveguide in the middle of ridge 6 and a portion of the neoprene jacket cut off to location 9. The cap 38 is slid back over the waveguide end portion and O-ring seal 48 is inserted onto the waveguide section. The two sections 14 and 16 of the clamp are brought together collaring the waveguide end portion and are then individually bolted securely to transition section 22 which as illustrated in FIG. 1 contains O-ring seal 50 seated in groove 52 thereof. This clamps ridge 6 between the recess rim 18 of the clamp and the protruding lip of transition 22. Seal 48 is then pushed forward until it abuts the rear tapered surface portion of clamp sections 14 and 16. In turn, the cap 38 is brought forward. Initially, seal 50 seated in transition 22 prevents the forward movement of cap 38 into final position, but with exertion of slightly greater pressure the cap "pops" into place immediately placing O-ring seal 50 under compression. Bolts 40 and 42 are then inserted through corresponding holes in transition 22 into the appropriate holes in cap 38 and are tightened securely. This compresses O-ring seal 48 against each of the abutting surfaces and provides an airtight seal between the rear wall of cap 38 and waveguide 2 to prevent gas leakage from the union.

As is apparent, the connector or union as assembled and illustrated in FIG. 1 forms a very smooth passage for microwave energy passing between waveguide 2 and transition 22 thus minimizing reflected energy which otherwise appears at abrupt discontinuities in the waveguide passage. The leakage of any gas from the waveguide out of the connector at this juncture is effectively prevented by the two ring seals 48 and 50. Thus, assuming a path exists for gas to escape from the waveguide between ridge 6 and protruding lip 32 and thereout into the space illustrated, the first O-ring seal 50 which abuts tightly both the inner surface of cap 38 and a rim on transition section 22 prevents the escape of gas in that direction. Going around the clamp to the rear end the gas cannot escape through the rear passage 39 in cap 38 because of the presence of O-ring seal 48. As discussed, the O-ring 48 compressively seals to the rear surface of the cap and the waveguide. Thus, assuming leakage from the waveguide end into this region within cap 38 or from the back of ridge 6 all that occurs is that the cap builds up a gas pressure equal to that in the waveguide; the gas cannot escape or leak to the surroundings. Accordingly, this solderless connector maintains the pressure in any system in which high-pressure gas is maintained in the waveguide.

The foregoing embodiment is presented to illustrate my invention. However it is to be understood that the arrangement and details used to illustrate the principles of my invention are not intended to limit my invention in any way, since numerous other arrangements and equivalents suggest themselves to those skilled in the art which do not depart from the spirit and scope of this invention.

Accordingly, it is to be expressly understood that my invention is to be broadly construed within the spirit and scope of the appended claims.

What I claim is:

1. Waveguide connector means for an elliptical waveguide of the type having ridges formed in the walls and an end formed at the middle of a ridge comprising:

a. clamping means having an opening therethrough for collaring an end portion of waveguide, a front face portion, and a rim portion surrounding said opening, said rim portion being recessed from said face portion for abutting and seating the outer surface of a ridge portion at said waveguide end portion;

b. waveguide flange means having a first face portion oriented facing said face portion of said clamping means, microwave passage means extending through said flange clamping means and a protruding lip surrounding said passage means and protruding from said first face portion for abutting the inner surface of said ridge portion at said waveguide end portion;

c. first fastening means joining together said clamping means and said flange means for clamping said waveguide ridge portion between said recessed rim of said clamping means and said protruding rim of said flange means;

d. cap means fitted over said waveguide end portion and having a hollowed out portion for enclosing said clamping means;

e. first compressible seal means, said first seal means being located inside of said cap means surrounding said waveguide, and abutting each of said cap means, said waveguide, and said clamping means;

f. second compressible seal means, said second seal means located inside said cap means proximate the front end thereof, and abutting both said cap means and said waveguide flange means; and

g. second fastening means joining together said cap means and said flange means.

2. The invention as defined in claim 1, wherein said clamping means further comprises two complementary split ring sections fitted together about said waveguide.

3. The invention as defined in claim 2 wherein said first and second seal means comprises a O-ring seal.

4. The invention as defined in claim 3 wherein said flange means includes a flange and a microwave transition section.

5. A waveguide section with a flanged connector comprising:

a. a waveguide section, said waveguide having spaced ridges each of which loops about said waveguide in a plane normal to the length of said wavelength, said waveguide section having an end located approximately in the middle of one such ridge to provide a ridge portion thereat;

b. clamping means having an opening therethrough collaring said waveguide end, a front face portion, and a rim portion surrounding said opening, said rim portion being recessed from said face portion for abutting and seating the outer surface of said ridge portion at said waveguide end;

c. waveguide flange means having a first face portion oriented facing said face portion of said clamping means, microwave passage means extending through said flange means, and a protruding lip bordering said passage means and extending from said first face for abutting the inner surface of said ridge portion at said waveguide end;

d, first fastening means joining together said clamping means and said flange means for clamping said ridge portion securely between said recessed rim of said clamping means and said protruding lip of said flange means;

e. cap means fitted over said waveguide having a hollow section for enclosing said clamping means;

f. first O-ring seal means surrounding said waveguide, said seal means located inside said cap means and abutting said cap means, said clamping means and said waveguide;

g. second O-ring seal means, said second seal means abutting said cap means and said waveguide flange means for forming therebetween a gastight seal; and

h. second fastening means joining together said cap means and said microwave flange means.

6. The invention as defined in claim 5 wherein said clamping means comprises a pair of complementary split ring sections oriented relative to each other to form a ringlike member.

7. The invention as defined in claim 6 wherein said flange means includes a microwave choke flange remote from said first face portion and a elliptical to rectangular transition between said choke flange and said first face portion.

8. The invention as defined in claim 7 wherein said cap means comprises a substantially cylindrical body having a bottom wall, said bottom wall including a passage therethrough corresponding in shape and slightly large in dimension than the corresponding shape and dimensions of said waveguide.

9. The invention as defined in claim 8 wherein said first fastening means comprises a plurality of bolts, said bolts extending from said clamping means to said flange means.

10. The invention as defined in claim 9 wherein said second fastening means comprises a plurality of bolts.

11. The invention as defined in claim 10 wherein said waveguide section includes a neoprene jacket and said jacket extends over said section and terminates at a location proximate the end ridge portion of said waveguide.

12. A solderless waveguide connector for use with a section of waveguide of the construction having ridges spaced apart along the length thereof, each of which forms a loop about the waveguide in a plane normal to the length of the waveguide, and which section terminates at the middle of one such ridge to form thereat a protruding lip comprising:

a. a ringlike clamping member having front and rear faces, a passage therethrough for collaring an end portion of waveguide end section, and a rim around said passage recessed from said front face to abut and seat the outer surface of an end ridge at the end of said waveguide section; said clamping member comprising two complementary split ring sections;

b. waveguide flange means, said flange means including a choke flange located at one end, a coupling face portion located at the other end, a microwave passage, including elliptical to rectangular transition means, extending therethrough, and a lip protruding from said coupling face portion surrounding said passage for abutting the inner surface of said end ridge;

c. a first plurality of bolts for joining together said clamping member and said flange means to clamp said end ridge between said recessed rim and said protruding lip;

d. a hollow cylindrical cap for covering and enclosing within the hollow thereof said clamping member, said cap having a bottom wall with a passage therethrough for inserting said cap over said waveguide section;

e. first O-ring seal means for insertion onto said waveguide section and within the hollow of said cap for abutting said back wall of said cap and said rear face of said clamping member to form a seal therebetween;

f. second O-ring seal means for location within the hollow of said cap for abutting an inner cylindrical wall of said cap and said waveguide flange means to form a seal therebetween; and

g. a second plurality of bolts for fastening together said cap and said flange means to secure said seals.