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METHOD OF MAKING A TRAVELING WAVE TUBE HELIX MOUNTING

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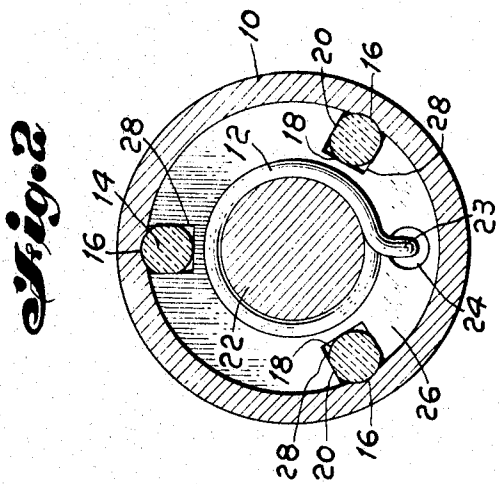


Fig. 2

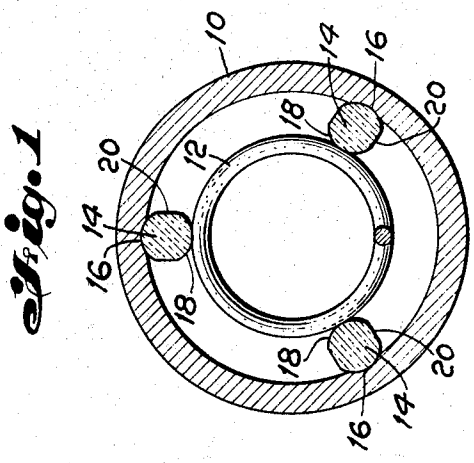


Fig. 1

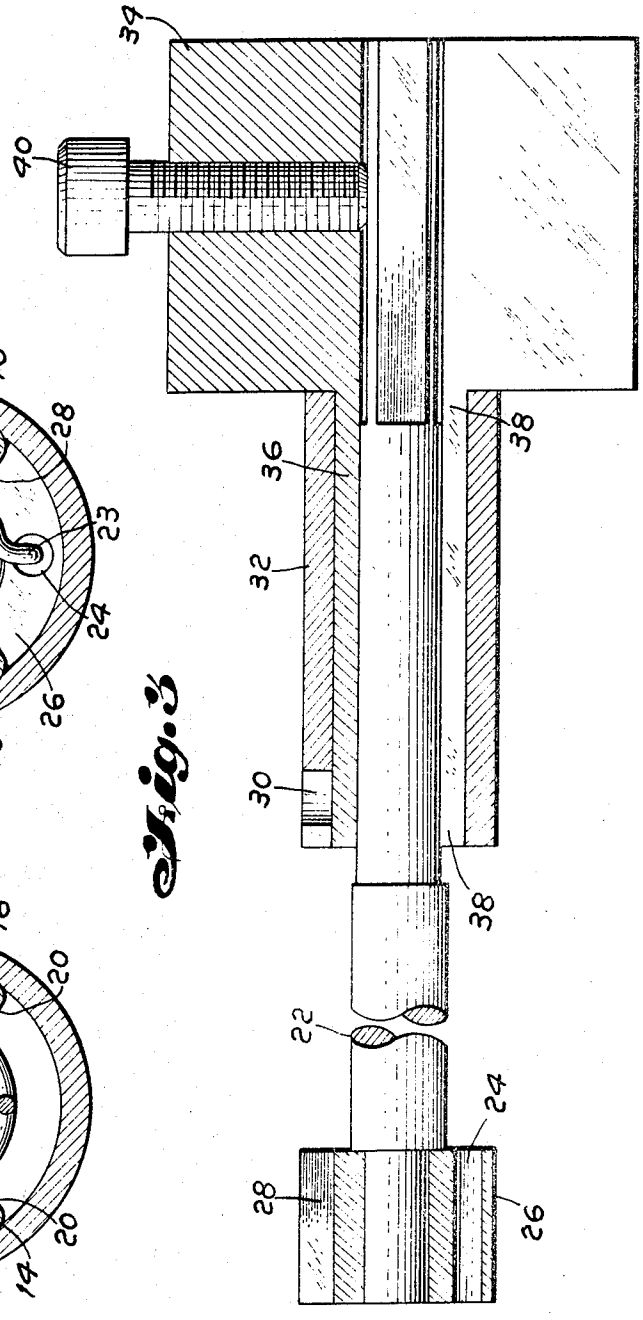


Fig. 3

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METHOD OF MAKING A TRAVELING WAVE TUBE HELIX MOUNTING

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This invention relates to a novel arrangement for mounting a slow wave helix structure within a traveling wave tube and particularly to a simplified assembly and method therefor which eliminates the need for various mechanical supports and positioning elements while providing an accurate and reliable device.

The helix and ceramic rod structures of traveling wave tubes are generally supported and secured in a desired position within a tube envelope by various devices such as annular disks or retaining rings, slotted rods, spring loaded members, counterbores in electrodes, spacers and brazed joints, some examples of which are shown in U.S. Patent No. 2,943,227, issued June 28, 1960 and assigned to the same assignee as the instant application. These added elements, of course, result in a more complex structure and time consuming assembly operations which are not readily adaptable to low cost manufacturing techniques. A more recent development has utilized a metallic tube shell which is slightly smaller in diameter than the rod-helix combination, with the shell being circumferentially distorted to fit over the other components. The shell, upon springing back into shape, provides direct mechanical support. The circular shape of the helix can also be deformed to fit within a glass envelope. The methods, however, have had limited reliability due to continued distortion of the shell or helix, rotational movement of the helix and poor heat transfer properties.

It is therefore the primary object of the present invention to provide a simple, reliable and efficient structure and method for mounting and securing a traveling wave tube helix and rod assembly.

A further object is to provide a simplified helix support structure which will retain a uniform position and have improved transfer of heat.

These objects are achieved by a novel arrangement wherein the helix itself forms a uniform resilient member applying pressure to the ceramic rods which bear against the tube shell to maintain the elements in position. A special tool may be employed to tighten or wind the helix into a smaller diameter and insert the rods and helix into the shell, after which the helix is released to spring out to its larger diameter and apply the necessary retaining force. The ceramic rods are secured in a predetermined radial arrangement by shallow longitudinal grooves formed along the inner surface of the tube shell. The mating rods and surface of the grooves also provide increased area for heat dissipation. The rods may be coated with carbon in a well known manner to provide a predetermined attenuation pattern for a radio frequency signal traveling along the helix, while direct current isolation between the helix and metal tube shell may be achieved by grinding flats along the sides of the rods to divide the coating into two separate portions. The details of the invention will be more fully understood and other objects and advantages will become apparent in the following description and accompanying drawings wherein:

FIGURE 1 shows a cross-section of the traveling wave tube envelope with the helix and rods secured in the normal position;

FIGURE 2 shows the helix in a smaller diameter position upon insertion into a tube shell by a special tool; and

FIGURE 3 shows a cross-section of the special insertion and helix winding tool to perform the assembly operation.

As shown in FIGURE 1, a tubular metal envelope or shell **10**, preferably of a non-magnetic metal such as stainless steel, Monel, or molybdenum, which will not easily distort under pressure and under the temperatures encountered during fabrication or use, encloses a slow wave metal wire or ribbon helix structure **12** and three dielectric support rods **14** accurately centering the helix. This arrangement is particularly useful in higher power periodic permanent magnet focusing tubes wherein the rods, preferably of ceramic material, are directly against the metal shell which is surrounded by the magnets and pole pieces. The rods are spaced equally about the circumference of the helix and are forced by the pressure of the helix acting as a coiled spring, to engage respective shallow longitudinal grooves **16** in the inner peripheral surface of the shell, which prevents rotational movement of the assembly. The grooves may be in the order of a few thousandths of an inch in depth and are formed by any suitable method such as burnishing or broaching. The added surface contacting the rods and the application of pressure provides greatly increased areas for efficient heat dissipation.

The rods may also be coated on their surface **18** with a lossy material, such as carbon, in a well known manner to apply predetermined attenuation or insertion loss patterns to the radio frequency signal traveling along the slow wave structure, to prevent undesirable oscillations. In order to provide direct current isolation between the helix and metal shell, the path formed by the attenuation coating between the two elements may be divided into separate inner and outer portions by grinding flats **20** to a depth of about .001 inch, along the opposite sides of each rod. This separation is primarily for the purpose of permitting measurements of beam current in the helix and has no noticeable effect on the attenuation or performance of the tube.

The insertion of a reduced diameter helix into the tube as shown in FIGURE 2 is achieved by the use of a special tool, a longitudinal cross-section of which is shown in FIGURE 3. The coiled helix is placed over a mandrel **22**, with a first longitudinal end wire **23** of the helix fitting into a hole **24** in an end cylinder **26** which is pressed onto the shaft or mandrel **22**. Three longitudinal grooves **28** are equally spaced about the periphery of the cylinder to accept one end of the support rods **14**. The other ends of the rods are engaged by end slots **30** in a sleeve **32** which is slipped over the mandrel from the other side. An end knob **34** bears against the end of sleeve **32** and has an extended hub portion **36** which slides over the mandrel within the sleeve. The knob has a radial slot **38** into which is inserted the longitudinal wire from the other end of the helix. The knob is then rotated, with the first end being stationary, to twist the helix around the mandrel to assume a smaller diameter. When the helix is sufficiently compressed against the mandrel, a screw **40** is fastened on the shaft thus securing the helix in position. The entire tool, with end cylinder **26** inserted first, is fitted into the tube shell, with the rods aligned with the grooves **16**. Screw **40** is then loosened and knob **34** released to permit the helix to expand to bear against and uniformly apply pressure against the rods **14** in engagement with grooves **16**. The diameter of the helix is now determined by the dimensions of the shell and rods. Thereafter knob **34** and sleeve **32** are removed from one end of the tube shell and the cylinder **26** and mandrel **22** from the other end, thus completing the assembly operation.

Since the helix is preferably made of refractory metals such as tungsten or molybdenum, the residual stress of the spring persists despite any temperature variations. A

well known centerless grinding technique for the rods and precise tooling of the shell grooves permits the attainment of required accuracies in centering and straightness of the assembly. It may thus be seen that the present invention provides a novel traveling wave tube helix assembly and method which has advantages of improved heat dissipation, minimum structural distortion and simplified construction.

While only a single embodiment has been illustrated, the invention is not to be considered as limited to the exact form or use shown and many other variations may be made in the particular design and configuration without departing from the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A method for assembling a slow wave helix structure within a traveling wave tube metal envelope having equally spaced longitudinal grooves formed along the inner periphery thereof comprising:

mounting a resilient helix on a shaft;

mounting and securing a plurality of equally spaced longitudinal dielectric rods around said helix;

rotating one end of said helix while maintaining the other end in a fixed position to tighten said helix from a larger to a smaller diameter about said shaft;

securing said one end to hold said helix in said smaller diameter position;

inserting said helix and rods on said shaft into said tube envelope with said rods in alignment with said grooves;

releasing said helix to expand to said larger diameter and force said rods into engagement with said grooves; and

removing said shaft.

2. A method for assembling a slow wave helix structure within a traveling wave tube metal envelope comprising:

forming equally spaced longitudinal grooves along the inner periphery of the metal envelope;

mounting a resilient helix on a shaft of an insertion tool;

mounting and securing a plurality of equally spaced longitudinal diameter rods on said tool around said helix; rotating one end of said helix with said tool while holding the other end in a fixed position to tighten said helix from a larger to a smaller diameter about said shaft;

securing said one end to hold said helix in said smaller diameter position;

inserting said tool with said helix and rods into said tube envelope with said rods in alignment with respective said grooves;

releasing said helix to expand to said larger diameter and forcing said rods into engagement with said grooves; and

removing said tool.

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