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Keim et al.

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[54] **ARRANGEMENT FOR WIDE BAND COUPLING OF A COAXIAL LINE TO A HOLLOW CONDUCTOR**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **333/33,** 333/97 R, 333/98 R

[51] **Int. Cl.** **H01p 5/08**

[58] **Field of Search** ..... 333/21 R, 33, 24 R, 333/97 R, 98 R

[56] **References Cited**

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Attorney—Benjamin H. Sherman et al.

[57] **ABSTRACT**

An arrangement for wide band inductive coupling of a coaxial line to a hollow conductor, by means of a coupling loop having a first leg extending in axial direction from the inner conductor of the coaxial line into the hollow conductor, and a second leg extending transversely from the first leg to the wall of the hollow conductor, with the free end portion of such first leg projecting beyond the second leg into the hollow conductor, at least two adjustable pins being provided for determining the coupling characteristics which pins extend inwardly from the hollow conductor sidewall, one of such pins being disposed opposite the first leg and extending inwardly toward the latter, while a second of such pins is disposed adjacent to but axially spaced from the projecting portion of the first leg.

10 Claims, 3 Drawing Figures

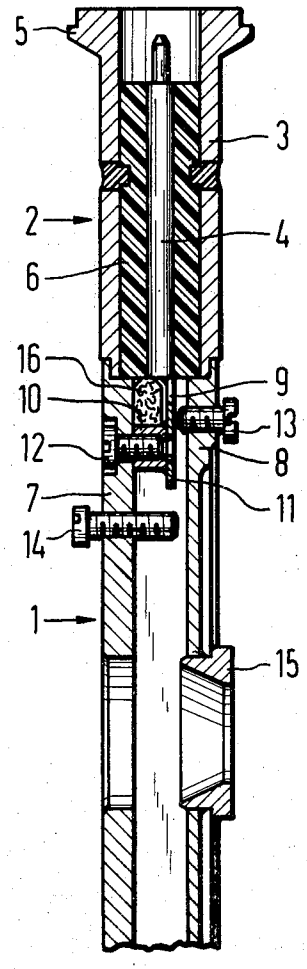


Fig. 1

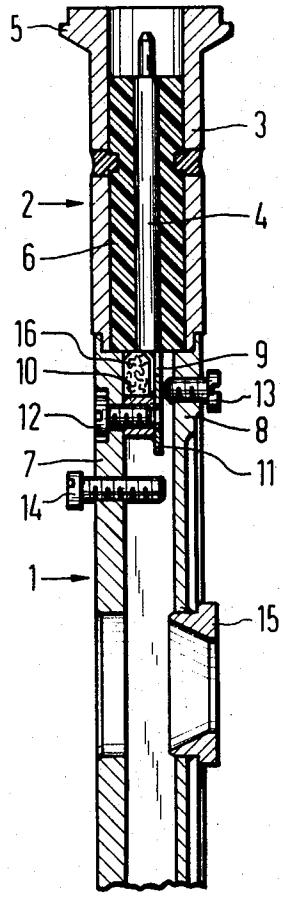


Fig. 2

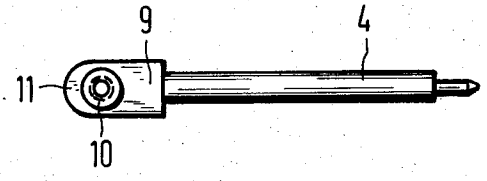
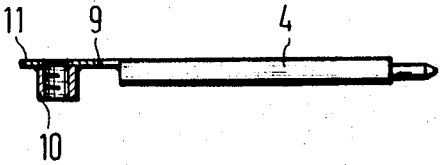


Fig. 3



ARRANGEMENT FOR WIDE BAND COUPLING OF A COAXIAL LINE TO A HOLLOW CONDUCTOR

BACKGROUND OF THE INVENTION

The invention is directed to an arrangement for effecting a wide band inductive coupling of a coaxial line to a hollow conductor employing a coupling look extending from the inner conductor of the coaxial line into the hollow conductor, in axial direction, and ultimately terminated at the sidewall of the hollow conductor.

Arrangements of this general type are already known. For example, see the publication "Micro-Transmissions Circuits," Ragan, 1948, pages 354 and 355. As brought out in publications such as that referred to it is usually stated that such inductive coupling arrangements have a number of disadvantages as compared to arrangements employing capacitive coupling, in view of which prior arrangements normally employ capacitive coupling. One of the principal disadvantages in such prior inductive coupling arrangements was the fact that they were efficient over only a very small band and thus were not suitable for most applications.

With the various types of frequency modulation tubes, the problem of effecting a transition from a coupling or decoupling hollow conductor, cooperable with the tube, to a coaxial line frequently arises as in most instances the users of such tubes prefer to use coaxial lines in their particular arrangements. As there is a continual and increasing demand for size reduction in connection with such tubes and circuits, it is extremely difficult in many cases, and at times even impossible, to provide a capacitive coupling of the coaxial line to the hollow conductor, since the coaxial line, for this purpose, must be connected to the side of the hollow conductor. This in turn, creates structural difficulties, particularly keeping in mind the fact that such frequency modulation tubes always require a magnetic system for the guidance of the electron beam.

The invention therefore is directed to the problem of producing an arrangement for wide band inductive coupling of a coaxial line to a hollow conductor, in which the coaxial line does not have to be connected to the hollow conductor at the side thereof.

SUMMARY OF THE INVENTION

The present invention employs an arrangement in which the coaxial cable extends in the same direction as the hollow conductor and employs a coupling loop which extends from the inner conductor of the coaxial line into the hollow conductor. The coupling loop is provided with a first leg extending, in the axial direction of the inner conductor of the coaxial line, into the hollow conductor, and a second leg extending from the first leg to the hollow conductor wall, with the first leg extending beyond the connection thereof to the second leg. In accordance with the present invention, cooperable with such coupling loop are at least two adjustable pins (which may be termed trimming pins), which are mounted on the hollow conductor and extend laterally into the latter, with a first pin being located in opposed relation to the first leg of the coupling loop and a second pin disposed adjacent the free end of the projecting portion of the first leg. Very favorable conditions arise if the second pin extends inwardly from the hollow conductor wall to which the second leg of the coupling loop is connected, whereby such pins extend inwardly from opposite walls of the hollow conductor.

In order to achieve a smooth transition from the hollow conductor to the coaxial line the coupling loop, at least a portion of the loop associated with the first leg is constructed as a strip line, whereby it thus becomes possible to match the impedance of the strip line to that of the coaxial line.

As in many cases in which transitions of the type hereinvolved are of special importance, namely for the transitional coupling of hollow conductors of a frequency modulation tube to external coaxial connection lines, flat hollow conductors are usually employed, and in view of their relatively small height or "thickness" (their lesser dimension) it is desirable, for achieving a sufficient effective length of the coupling loop, to attach the latter eccentrically at the adjacent end of the inner conductor of the coaxial line. It is particularly desirable to further reduce the actual length of the first leg, to prevent undesirable extension of the coupling loop into the hollow conductor, which may disturb the transition from the tube to the hollow conductor, and at the same retain an effective length sufficient to achieve a adequately large effective coupling loop, the space between the coupling loop and the wall of the hollow conductor contacted thereby is filled, at least partially, by a dielectric. The hollow conductor wavelength is thereby decreased in this area whereby a smaller axial geometric length of the coupling loop corresponds to a sufficiently large effective electrical length.

In a particularly advantageous and stable structure, in accordance to a further feature of the invention, the second leg of the coupling loop is of tubular construction and suitably connected, for example by soldering to one side of the first leg, with such tubular second leg being secured to the hollow conductor sidewall by a screw extending through an opening in the wall and threaded into the second leg.

The cooperable adjustable trimming pins may be of very simple construction i.e., in the form of screws which are threaded into cooperable bores in the hollow conductor sidewall, and if the coupling arrangement is to be employed in an evacuated area may be secured in vacuum tight relationship to the conductor sidewall, following completion of the desired optimum adjustment, for example by soldering or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings where like reference characters indicate like or corresponding parts:

FIG. 1 is a longitudinal section through a coupling arrangement according to the invention;

FIG. 2 is a plan view of merely the coupling loop and inner conductor of the coaxial line; and

FIG. 3 is a side elevational view thereof, with the coupling loop being illustrated in section.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring to FIG. 1 the reference numeral I generally designates a flat hollow conductor, adapted to be connected at the ring 15 to a frequency modulation tube (not illustrated), while the reference numeral 2 generally designates a coaxial line section comprising an outer conductor 3 and an inner conductor 4 which are concentrically disposed, with the inner conductor

being rigidly connected to the outer conductor by a dielectric sleeve or plug **6**, whereby the coaxial line section and the flat hollow conductor extend in the same longitudinal direction. The outer conductor **3** of the coaxial line section may be provided with a flange **5** or other suitable construction by means of which the coaxial line section may be operatively connected to a cooperable coaxial line.

Extending into the adjacent end of the hollow conductor is a coupling loop having a first leg **9**, extending in the same direction as the axes of the coaxial section **2** and hollow conductor **1**, and a second leg **10** extending transversely to the first leg and contacting the adjacent wall **7** of the hollow conductor.

The first leg of the coupling loop is designed as a strip line, providing an inductive coupling of the coaxial line **2** to the hollow conductor **1**, and as illustrated in FIGS. **1** and **3** is connected, by means of solder or the like, in eccentric relation to the adjacent inner end of the inner conductor **4**, while the second leg **10** is of tubular configuration having an internally threaded bore in which a mounting screw **12**, extending through the side wall of **7** of the hollow conductor, is threaded to firmly mount the second leg **10** rigidly to the adjacent sidewall. It will be appreciated, however, that instead of the preferred tubular construction, the second leg could be constructed in the form of a small strip or wire which is soldered to the inner face of the hollow conductor wall **7**. The first leg **9** of the coupling loop, as illustrated in FIGS. **1** and **3**, is extended, for adjustment purposes, longitudinally beyond its connection to the second leg **10**, with the free end of the leg **9** forming an extension section or projection **11**.

In order to effect a decrease in the hollow conductor wave length in the region adjacent the coupling loop, and to achieve a sufficiently large electrical length of the coupling loop while employing a relatively short first leg **9**, the space defined by the legs **9** and **10**, and the adjacent hollow conductor wall **7** may be at least partially filled with a dielectric material, for example a small ceramic block **16**.

The physical length of the leg **9** thus can be relatively small without impairing the coupling, whereby the entire coupling arrangement is disposed relatively remote from the ring **15**, which if disposed too close to the ring might have a disturbing effect with respect to the transition from the tube to the hollow conductor. Extending inwardly transversely with respect to the axis of the hollow conductor, are a plurality of adjustable trimming pins, two such pins **13** and **14** being employed in the illustrated embodiment of the invention, which may be of very simple construction, for example in the form of screws threaded into the hollow conductor sidewall.

The first such pin **13** is mounted in the wall **8** of the hollow conductor with the free inner end of the pin **13** being disposed in opposition to the first leg **9** of the coupling loop, while the second pin **14** is mounted in the opposing wall **7** of the hollow conductor and is positioned inwardly along the hollow conductor axis with respect to the projecting end **11** of the first leg **9** of the coupling loop, as will be apparent from a reference to FIG. **1**.

The optimum adjustment, determinative of the magnitude of the coupling, and width of the coupling band, is dependent upon the adjustment of the distance each pin extends into the hollow conductor, which adjustment may be readily effected by suitable rotation of the respective screws forming the pins.

It will be apparent that the physical and electrical parameters of the coupling arrangement illustrated may be readily determined by those skilled in the art to meet particular operating conditions.

Likewise if, the coupling arrangement is associated with an evacuated conductor, the connection between the second leg **10** and the side wall **7**, including the screw **12**, as well as the junctures between the screws **13** and **14** and their respective sidewalls, may be rendered vacuum-tight by soldering or the like, such soldering of the screws **13** and **14** taking place following the optimum adjustment thereof.

Having thus described our invention, it will be obvious that although minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim:

1. An arrangement for wide band inductive coupling of a coaxial line to a hollow conductor, comprising a coupling loop having a first leg extending in axial direction from the inner conductor of the coaxial line into the hollow conductor, and a second leg extending transversely from the first leg to the wall of the hollow conductor, with the end portion of said first leg projecting beyond the second leg into the hollow conductor, and at least two adjustable trimming pins extending inwardly from the hollow conductor sidewall, one of such pins being disposed opposite said first leg and extending inwardly toward the latter, and a second of such pins being disposed adjacent to but axially spaced from the projecting end portion of said first leg.

2. An arrangement according to claim **1**, wherein the second adjustable pin extends inwardly from the hollow conductor wall to which the second leg of the coupling loop is connected.

3. An arrangement according to claim **1**, wherein the space defined by the respective legs of the coupling loop and adjacent hollow conductor wall is at least partially filled by a dielectric.

4. An arrangement according to claim **1**, wherein at least the first leg of the coupling loop is in the form of a strip line.

5. An arrangement according to claim **1**, wherein the coupling loop extends eccentrically with respect to the inner conductor of the coaxial line.

6. An arrangement according to claim **1**, wherein the second leg of the coupling loop is of tubular configuration and secured to the hollow conductor wall by a screw extending therethrough and threaded into said second leg.

7. An arrangement according to claim **1**, wherein said adjustable pins are in the form respective screws extending from the exterior into threaded bores in the hollow conductor walls.

8. An arrangement according to claim **7**, wherein said screws are soldered, in their adjusted positions, to the hollow conductor.

9. An arrangement according to claim **1**, wherein said first leg of the coupling loop extends eccentrically with respect to the inner conductor of the coaxial line and at least such first leg is in the form of a strip line, said second leg being of tubular configuration and se-

cured to the hollow conductor wall by a screw extending therethrough and threaded into said second leg, the space defined by the respective legs of the coupling loop and adjacent hollow conductor wall being at least partially filled by a dielectric, said second adjusting pin extending inwardly from the hollow conductor wall to which the second leg of the coupling loop is connected, said pins comprising respective screws extending from the exterior through threaded bores in the hollow conductor walls.

10. An arrangement according to claim **9**, wherein said adjusting screws are soldered, in their adjusted positions, to the hollow conductor.

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