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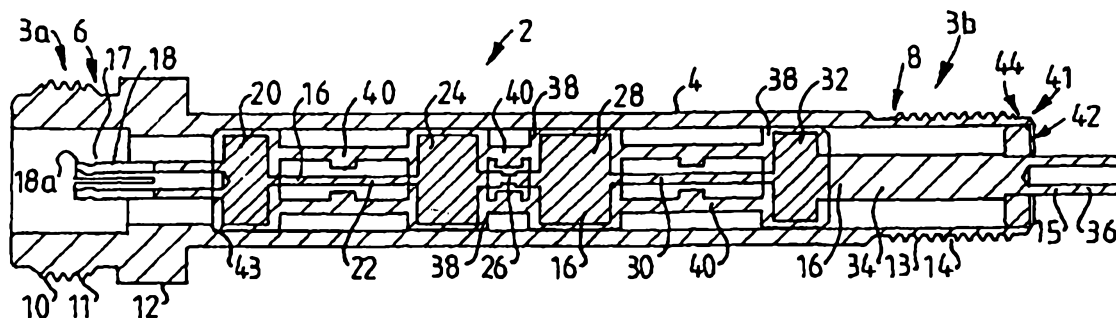
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(54) Title: FILTER



(57) Abstract

A filter comprises a first end (6), a second end (8), a conducting casing (4), at least one central conductor (16), and connecting means (3a, 3b) at each of the ends (6, 8), the casing (4) extending along an imaginary axis (A) and is intended to accommodate the conductor (16) along this imaginary axis (A), and further the conductor (16) is provided with capacitance generating portions (20, 24, 28, 32) and inductance generating portions (22, 26, 30), the connecting means (3a) at the first end (6) of the filter comprising a first connecting member (10) connected to the casing (4) and a second connecting member (17) connected to the conductor (16), the connecting means (3b) at the second end (8) of the filter comprising a third connecting member (13) connected to the casing (4) and a fourth connecting member (37) connected to the conductor (16). According to the invention both the second and the fourth connecting members (17, 37) are provided integrally with the conductor (16).

FILTER

THE BACKGROUND OF THE INVENTION

5 The present invention relates generally to filters and more particularly to a filter of a particular construction including a first end, a second end, a conducting casing, at least one central conductor, and one connecting means at the ends, respectively.

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RELATED ART

Such a filter is known from JP-08018305 A, which accordingly describes the technique, which is used as a base for the invention.

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SUMMARY

20 In radio base stations, frequency filters, especially low-pass filters (LP-filters), are used. The filters comprises separate units and can be integrated with and connected to other units by means of soldering or mechanical joining. Connections involve always a risk for, for instance, bad electrical contact and the more pieces and connections there are the more problems with contact will arise. Another problem with conventional LP-filters, where the conductor is enclosed in a plastic tube, which in turn is enclosed in a conducting casing, is that there could be a play between the insulator and the two conductors of the capacitor, which will give rise to a bad defined
25 capacitance, which means an uncertain interval for the passed frequency.

30 In one aspect, the present invention provides a filter including a first end, a second end, a conducting casing, at least one central conductor, and connecting means at each of the ends, the casing extending along an imaginary axis (A) and is intended to accommodate the conductor along this imaginary axis (A), and further the conductor is provided with capacitance generating portions and inductance generating portions, the connecting means at the first end of the filter including a first connecting member connected to the casing and a second connecting member connected to the conductor, the connecting means at the second end of the filter

including a third connecting member connected to the casing and a fourth connecting member connected to the conductor, wherein both the second and the fourth connecting members are provided integrally with the conductor.

5 The above mentioned problems are solved by a filter characterised in that connecting members are provided integrally with the conductor. The finesse is that the filter is integrated with a connector. The contact is actually the end of the conductor of the filter.

10 It is preferred that an insulator covers at least one part of at least one of the capacitance generating portions of the conductor and that the insulator is arranged on said portion. The insulator gives a protection against breakdown voltage across the capacitance generating portions and the casing.

15 Preferably the insulator is cast directly on said capacitance generating portions. This provides that the capacitance can be determined more precisely since play that can occur between the insulator and one of the conductors of the capacitor is avoided.

20 Preferably there is at least one axially directed junction means between each capacitance generating portion, which connects the insulator around these with each other, the junction means consisting of the same material that is cast around the portions, the insulator and the junction means providing a continuous unit. The function means thereby enables the casting of the insulator in one piece.

25 Advantageously the casing is provided with at least one stopping means to fasten the conductor co-axially in the casing.

30 Further it is advantageous that one of the stopping means is a projection on the inside of the casing at one of the ends, whereby the capacitance generating portion, which is closest to the second connecting member and together with the insulator

has a diameter that is sized such that it precisely fits in the rest of the casing, is stopped at the projection.

It is suitable that at least one of the stopping means comprises at least one emboss in the casing, this emboss causing a decrease in the inner diameter of the casing. This decrease in diameter pushes preferably the capacitance generating portion that is closest to the second or fourth connecting member, and thus the whole conductor, axially towards the stopping means in the opposite end.

Further at least one of the stopping means can comprise a ring of insulating material, which is placed around the soldering connection end against one part of the conductor, which has a slightly larger diameter than the soldering connection end and a ring-shaped edge, outermost at the other end of the casing, which is folded in over the ring, this folding causing that the ring and thereby the whole conductor is pressed against the stopping means in the opposite end. This contributes to a mounting of the conductor in the casing without play.

At least one of the second and fourth connecting members could be a soldering connection end.

It is suitable that at least one of the second and fourth connecting members is provided as a circularly cylindrical shell extended in the longitudinal direction, one of the ends of which is free, and from this is at least one axially directed slit taken from the free end towards the capacitance generating portion that is closest to the fourth connecting member.

Preferably the first connecting member and the third connecting member are provided integrally with the casing and the casing is provided in one piece. This provides that grounding problems are decreased since the connector and the filter have the same potential, when they are provided integrally.

Preferably the first and third connecting members are provided with threads. Hereby a safe connection is obtained between the filter and connecting parts.

Preferably the conductor is provided in one piece, whereby the filter is a low-pass filter.

Alternatively, at least one of the capacitance generating portions is divided into two smaller portions, which are following each other in the direction of the axis, the portions being separated by a gap, which is filled with at least one dielectric, for example air, ceramic or a polymeric material, whereby the filter is a band-pass filter.

It is advantageous in the manufacturing that said dielectric is of the same insulating material that is cast around the portions, whereby the insulator and the dielectric together compose a continuous unity.

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It is further advantageous that the casing as well as the different portions of the conductor are essentially circularly cylindrical, the capacitance generating portions having the largest diameter, and that at least one of the portions is arranged co-axially along the imaginary axis (A).

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Suitably, at least the capacitance generating portions and the inductance generating portions of the conductor are silvered. Hereby a good conductivity is obtained since the current is conducted along the surface.

25

Since the number of pieces is reduced also the manufacturing costs are reduced.

The term "comprises", and grammatical variations thereof such as "comprising" when used in the description and claims does not preclude the presence of additional features, integers, steps or components; or groups thereof.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a filter with integrated connecting means in perspective.

Fig. 2 shows the filter according to fig. 1 in a face view.

Fig. 3 is a longitudinal section of the filter according to fig. 2.

Fig. 4 shows a Low-Pass (LP) filter with integrated connecting means of the same sort in both ends.

Fig. 5 shows a Band-Pass (BP) filter with integrated connecting means of the same sort in both ends.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a view in perspective of a first embodiment of a filter 2 according to the invention. The filter 2 comprises integrated connecting means 3a and 3b. The filter 2 comprises also an essentially circularly cylindrical, metallic casing 4, which has a first open end 6 and a second open end 8. The first open end 6 comprises outermost a first connecting member 10 provided with threads 11, and closer to the middle of the casing, but still in the first end 6, a part 12, a key handle, which has a slightly larger diameter than the casing 4 and which comprises two opposite bevels. The other end 8 comprises a third connecting member 13, which is provided with threads 14. Besides keeping connecting parts in place the threads 11, 14 contribute in providing good contact with connecting parts.

Fig. 2 shows the filter 2 according to figure 1 with a concentric axis A passing through the filter 2 in its longitudinal direction.

Fig. 3 shows a longitudinal section of the first embodiment of the filter 2. According to this embodiment the filter 2 is a Low-Pass (LP) filter and the connecting means 3a is provided as a standard connector. The LP filter 2 comprises a conductor 16

that passes through the whole filter 2 inside the casing 4 in the direction of the axis A. The conductor 16 is turned in one piece and comprises ten essentially circularly cylindrical portions 18,20,22,24,26,28,30,32,34,36 with varying diameters. In this embodiment all portions 18,20,22,24,26,28,30,32,34,36 of the conductor 16 are arranged co-axially along the axis A, but it is also possible that only one or a few of the portions 18,20,22,24,26,28,30,32,34,36 are arranged co-axially along the axis A. Every portion is connected to the closest previous portion according to the above order. A second connecting member 17 comprises the first portion 18 of the conductor 16, which is arranged concentrically in the first end 6 of the filter 2. The portion 18 is shaped as a longitudinal extended, circularly cylindrical shell, one of the ends 18a of which is free, and from this shell are four axially directed slits taken from the free end 18a towards the second portion 20. Of course the number of slits can be varied. The second, fourth, sixth and eighth portions 20,24,28,32 have a larger diameter than the third, fifth and seventh portions 22,26,30. The third and seventh portions 22,30 have a longer axially extension than the fifth portion 26. The ninth portion 34 has a larger diameter than the third, fifth and seventh portions 22,26,30, but a smaller diameter than the second, fourth, sixth and eighth portions 20,24,28,32. This portion 34 is only meant to give the filter 2 a desired length and has no further function for the filtering. A forth connecting member 37 is in this embodiment the tenth portion 36. It projects partly outside the casing 4 at the second end 8 of the casing 4 and is intended to be a soldering connection end. This portion 36 is hollow to give a small dissipation of heat during soldering and its diameter is slightly smaller than the diameter of the ninth portion 34.

The portions 20,24,28,32 and the portions 22,26,30 operate together with the metallic casing 4 as a LP filter, as shown in JP-08018305 A. Thus the portions 20,24,28,32 generate capacitance together with the metallic casing 4 while the portions 22 26 30 generate inductance. The number of, the size of and the distance between the capacitance generating portions 20,24,28,32 determine the frequency characteristic of the filter. The material of the conductor 16 ought to have good

contacting features and to be elastic. Suitable such materials are tinbronze or berylliumcopper. The conductor 16 is in the first portion 18 gilded such that a good contact will be obtained, and the remaining part of the conductor is silvered to achieve a good conductivity.

5

The portions 20,24,28,32 are completely covered by an insulator 38, cast around them. The insulator 38 is provided for mechanically fasten the different parts in the filter and to protect against breakdown voltage. To avoid capacitance at the portions 22,26,30, where inductance is wanted they should not be covered by the insulator but surrounded by air that has a lower dielectric constant than the insulator and thereby provides a lower capacitance. There are two axially directed junction means 40 between every portion 20,24,28,32, which connects the insulator around these portions with each other. The number of junction means can of course be varied. The junction means 40 consists of the same insulation material that is cast around the portions 20,24,28,32, and they have as only technical function to facilitate the cast of the insulator 38, the insulator 38 and junction means 40 providing one continuous unity. Suitable insulation materials are polyetherimid, polyarylamide or polyetrafluorethene of a quality possible to cast.

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At the first end 6 of the casing 4 the casing 4 has a inner diameter that is slightly smaller than the inner diameter of the rest of the casing. This projection provides a first stopping means 43, which is intended to keep the conductor 16 of the filter 2 in the right place in the casing 4. In the second end 8 of the filter 2 there is a second stopping means 44, which comprises a ring 42 of insulating material, which is placed around the tenth portion 36 against the ninth portion 34, which has a slightly larger diameter than the tenth portion 36. The stopping means 44 comprises further a ring-shaped edge 41, outermost at the second end 8 of the casing 4, which is folded in over the ring 42. This folding causes that the ring 42 and thus also the whole conductor 16 is pressed against the first stopping means 43.

Fig. 4 shows a longitudinal section of a second embodiment of the filter 2 according to the invention. According to this embodiment the filter 2 has integrated connecting means 3a of the same sort in both ends. The details are the same as in Figures 1-3, besides that the second end 8 of the filter 2 in this embodiment being on the whole the same as the first end 6, which is of the same kind as in the previously described embodiment. This means that the third connecting member 13, in this second embodiment, is of the same kind as the second connecting member 17. A portion 18' of the same kind as the first portion 18 replaces also the ninth and tenth portions 34,36. The difference between the first and second end 6,8 is only that the first stopping means 43, the projection, present in the first end 6, is not present in the second end 8. During the mounting the conductor 16 is pushed in through the second end 8 of the casing 4, and, in order to fasten the conductor 16 in the casing 4 and provide a second stopping means 44, the casing 4 is embossed in the second end 8 such that a decreased inner diameter 50 in the casing 4 is provided and the eighth portion 32 is pressed axially towards the middle.

Fig. 5 shows longitudinal section of a third embodiment of the filter according to the invention. According to this embodiment the filter is a Band-Pass (BP) filter. Such a filter allows frequencies in a certain interval to pass as distinguished from the LP-filter that allows all frequencies under a certain frequency to pass. The details are the same as in Figures 1-4 except that two of the capacitance generating portions 24,28 have been divided into two smaller, circularly cylindrical portions 24a', 24b' and 28a', 28b', respectively, following each other in the direction of the axis. The portions 24a' and 24b' 'and 28a', 28b', respectively, are separated by a gap 47, which is filled with a dielectric, for example air, ceramic or the same insulating material that is cast around the portions 20,24,28,32. In the last mentioned case the insulator 38 and the dielectric together with the junction means 40 provide a continuous unit. To provide a BP-filter, one or more of the capacitance generating portions 20,24,28,32 could be divided as the portions 24,28 in the third embodiment, Fig. 5.

Of course the BP-filter can be provided with a connecting means 3a in one of the ends and a connecting means 3b in the other end or a connecting means 3b in both ends.

- 5 Other variants concerning the location of the insulator 38 in the filter 2 could for example be that the whole conductor 16 is covered by the insulator, which is cast around it. Then it would also be possible to replace the two stopping means 43,44 by one stopping means, which is an emboss somewhere on the casing. This emboss causes a decrease in the inner diameter in the casing 4, which in turn causes the insulating material to deform a bit, and the conductor 16 is fixed in the casing 4.
- 10

The ring 42 could also provide a continuous unit together with the cast insulator 38.

- Of course a filter 2 with connecting means 3b of the same sort in each end is possible. Hereby a filter 2 that is connected by soldering in both ends is achieved.
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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A filter including a first end, a second end, a conducting casing, at least one central conductor, and connecting means at each of the ends, the casing extending along an imaginary axis (A) and is intended to accommodate the conductor along this imaginary axis (A), and further the conductor is provided with capacitance generating portions and inductance generating portions, the connecting means at the first end of the filter including a first connecting member connected to the casing and a second connecting member connected to the conductor, the connecting means at the second end of the filter including a third connecting member connected to the casing and a fourth connecting member connected to the conductor, wherein both the second and the fourth connecting members are provided integrally with the conductor.
2. A filter according to claim 1 wherein an insulator covers at least one part of at least one of the capacitance generating portions of the conductor, and that the insulator is arranged on said portion.
3. A filter according to claim 2 wherein the insulator is cast directly on said capacitance generating portions.
4. A filter according to claim 3 wherein there is at least one axially directed junction means between each capacitance generating portion which connects the insulator around these with each other, the junction means consisting of the same material that is cast around the portions, the insulator and the junction means providing a continuous unit.
5. A filter according to any one of the preceding claims wherein the casing is provided with at least one stopping means to fasten the conductor co-axially in the casing.
6. A filter according to claim 5 wherein one of the stopping means is a projection on the inside of the casing at one of the ends, whereby the capacitance generating portion, which is closest to the second connecting member and

together with the insulator has a diameter that is sized such that it precisely fits in the rest of the casing, is stopped at the projection.

7. A filter according to claim 5 or 6 wherein at least one of the stopping means includes at least one emboss in the casing, this emboss causing a decrease in the inner diameter of the casing.

8. A filter according to any one of the claims 5 to 7 wherein at least one of the stopping means includes a ring of insulating material, which is placed around the end adapted for soldering connection against one part of the conductor, which has a slightly bigger diameter than the end adapted for soldering connection, and a ring-shaped edge, outermost at the other end of the casing, which is folded in over the ring, this folding causing that the ring and thereby the whole conductor is pressed against the stopping means in the opposite end.

9. A filter according to any one of the preceding claims wherein at least one of the second and fourth connecting members is an soldering connection end, which has the form of a circularly cylindrical shell.

10. A filter according to any one of the preceding claims wherein at least one of the second and fourth connecting members is provided as a circularly cylindrical shell extended in the longitudinal direction, one of the ends of which is free and from this at least one axially directed slit is taken from the free end towards the capacitance generating portion that is closest to the fourth connecting member.

11. A filter according to any one of the preceding claims wherein the first connecting member and the third connecting member are provided integrally with the casing, and that the casing is provided in one piece.

12. A filter according to any one of the preceding claims wherein the first and third connecting members and are provided with thread.

13. A filter according to any one of the previous claims wherein the conductor is provided in one piece, whereby the filter is a low-pass filter.

14. A filter according to any one of the claims 1 to 12 wherein at least one of the capacitance generating portions is divided into two smaller portions which are following each other in the direction of the axis, the portions being separated by a gap, which is filled with at least one dielectric, whereby the filter is a band-pass filter.

15. A filter according to claim 14 wherein said dielectric is of the same insulating material that is cast around the portions, whereby the insulator and the dielectric compose a continuous unity.

16. A filter according to any one of the preceding claims wherein the casing as well as the different portions of the conductor are substantially circularly cylindrical, the capacitance generating portions having the largest diameter, and that at least one of the portions is arranged co-axially along the imaginary axis (A).

17. A filter according to claim 1 substantially as hereinbefore described with reference to the accompanying Figures.

18. A filter substantially as hereinbefore described with reference to the accompanying Figures.

DATED this 17th day of September 2003

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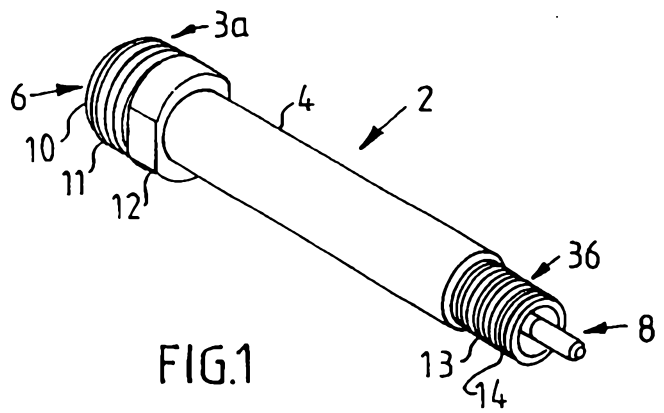


FIG. 1

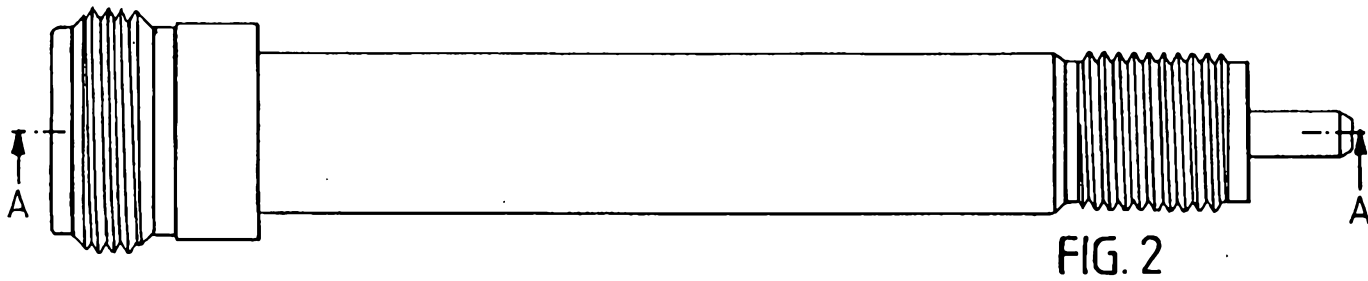


FIG. 2

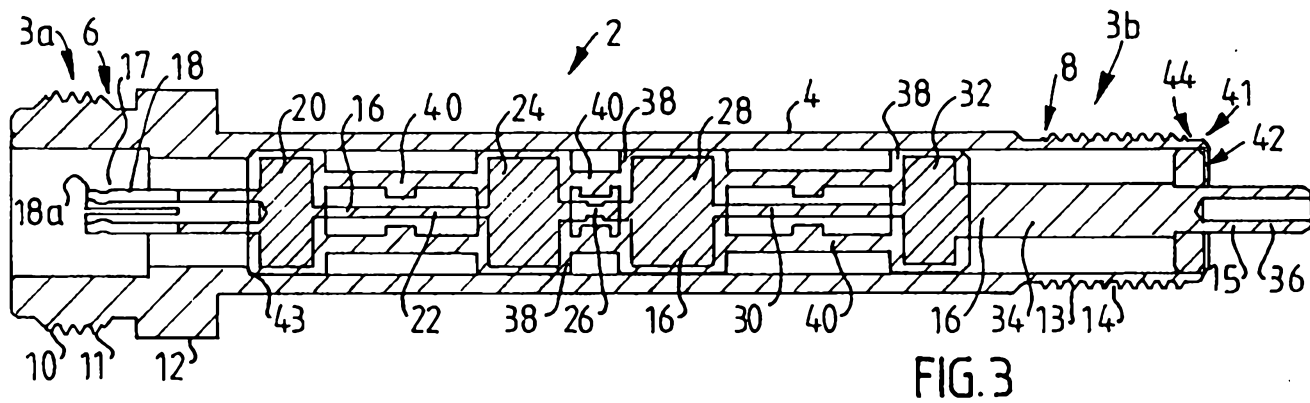


FIG. 3

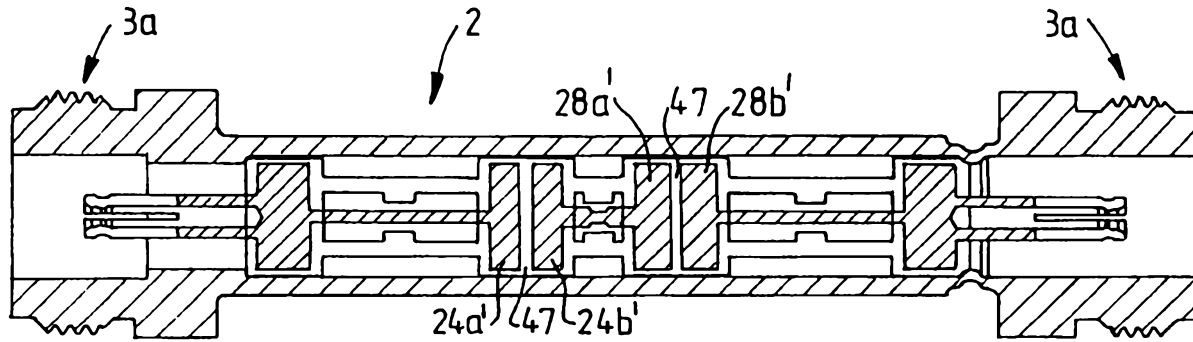


FIG. 5

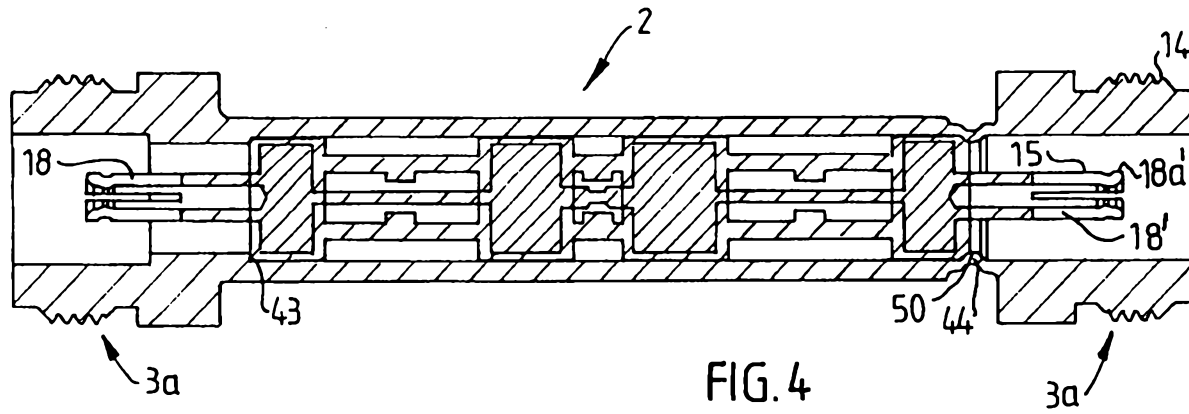


FIG. 4