July 19, 1960 R. ABRAMS ET AL 2,946,029

IMPEDANCE ASSEMBLY

Filed Dec. 22, 1955

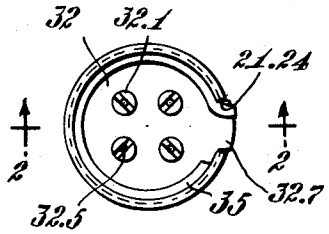


Fig. 1

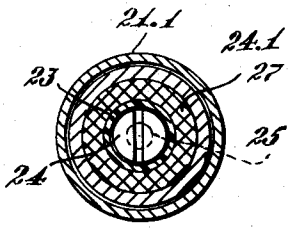


Fig. 3

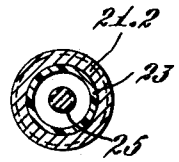


Fig. 4

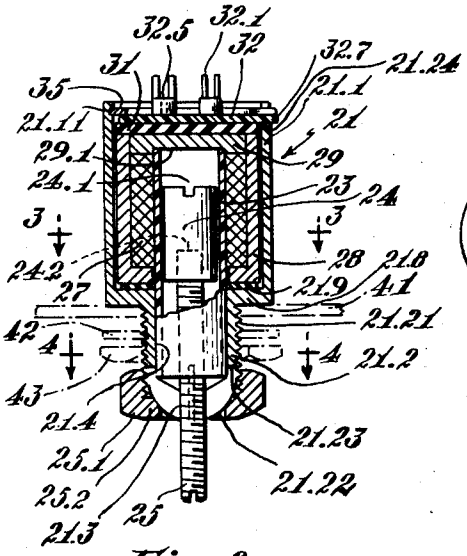


Fig. 2

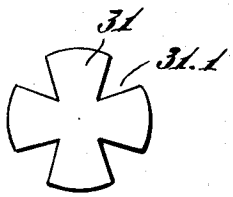


Fig. 5

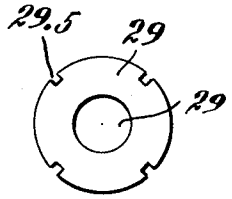


Fig. 6

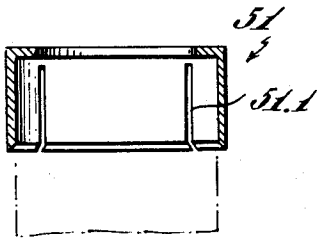


Fig. 7

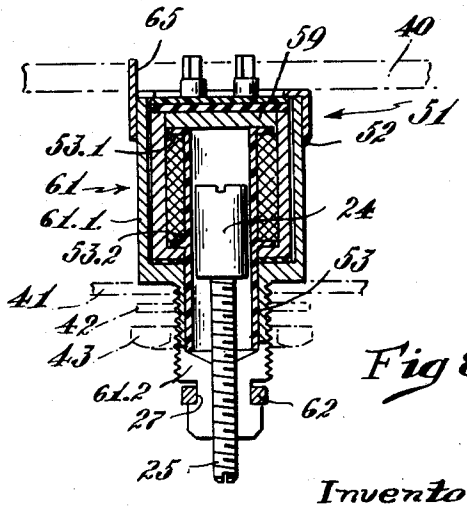


Fig 8

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IMPEDANCE ASSEMBLY

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3 Claims. (Cl. 336—136)

The present invention relates to tunable impedance devices of the type having an adjustable core member.

Objects of the invention are to provide adjustable impedance devices, such as for example coil forms, that are especially suitable for miniature or near miniature embodiments, to provide such devices that are shock resistant, exceptionally rugged and precise, and yet comparatively inexpensive, to provide such devices which are electrically shielded against radiation and therefore especially suitable for use in close proximity of other elements in circuits where adjacent mounting is necessary, to provide such devices which give a wide variety of possibilities of mounting as well as modification of electric characteristics such as type of windings or electrodes, or number of terminals, and to provide devices of this type which permit partial assembly at the factory and easy and secure completion and mounting with basic tools.

A brief summary of the invention, indicating its nature and substance for attaining the above objects, is as follows.

A tunable impedance device according to a principal aspect of the invention comprises tubular form means such as a coil form, housing means which have at one end stud means with mounting means on the outside of a cavity that fits the form means and which housing means has at the other end shell means forming a chamber that is wider than the form means, the form means extending from the cavity into the shell means with clearance to accommodate an impedance element such as a coil and stationary cup core members, and means axially penetrating the stud means into the space within the form means, for carrying an internal core member and for axially adjusting it within the form means. In a preferred embodiment, the shell contains cup core members surrounding a coil on the form means and elastic spacing members within the shell which are compressed by a terminal board that is fixed to the open end of the shell with a spring ring or a cap, which latter can be provided with a ground tab.

These and other objects, and aspects of the nature of the invention will appear from the herein presented description of several typical embodiments illustrating its novel characteristics.

The description refers to a drawing in which

Fig. 1 is the top elevation of an assembly according to the present invention with part of the spring ring broken away to show the terminal board key in its shell notch;

Fig. 2 is a section on lines 2—2 of Fig. 1;

Fig. 3 is a section on lines 3—3 of Fig. 2;

Fig. 4 is a section on lines 4—4 of Fig. 2;

Fig. 5 is a top elevation of the spacer that can be incorporated in the assembly;

Fig. 6 is a top elevation of the cup core cap incorporated in the assembly;

Fig. 7 is an axial section through the retaining cap of a second embodiment of the invention; and

Fig. 8 is an axial section similar to Fig. 2, of a second embodiment of the invention.

In Figs. 1 to 4, the housing **21** has a shell portion **21.1** and a stud portion **21.2**. The shell portion has, in the embodiment shown, an annular recess **21.11** for the retaining spring ring to be described below, and a notch **21.24** for the key **32.7** of the terminal assembly to be described below. The stud portion **21.2** has a cylindrical portion **21.21**, threaded on the outside, and a hemispherical portion **21.22** which latter is provided with a plurality, for example four slits **21.23**. The hemispherical portion **21.22** of the stud portion **21.2** of the housing **21** has an axial perforation **21.3** with an inside thread to receive the spindle **25** of the tuning core.

The chamber of the shell portion **21.1** leads into the cavity of the stud portion by way of a shoulder **21.9**.

A form **23**, made of insulating material, fits the cavity **21.4** of the stud portion **21.2**. Within the form **23** is slidably inserted a tuning core or slug **24** which is mounted on the above mentioned spindle **25** that is threaded into the axial hole **21.3** of the hemispherical portion **21.22** of the stud portion **21.2** of the housing.

In the present embodiment which represents a tuning reactance, the core is made of iron powder and has a slot **24.1** for screwing it onto the spindle **25** by means of an inside threaded recess **24.2**.

On the form **23** is wound a wire winding **27**, indicated by cross-hatching in Figs. 2 and 3. The winding is surrounded by a cup core **28** and a cup core cap **29**, both made of iron powder material. As indicated in Fig. 2, the cup core cap has a recess **29.1** and a number, such as four, notches **29.5**, as indicated in Fig. 6. On the cup core cap fits a spacer **31** of elastic material such as sponge rubber which is also shown in Fig. 5 and which has a number, for example four, notches **31.1**. Between the bottom of the cup core **28** and the shoulder **21.8** is a rubber washer **21.9**.

On the spacer **31** fits the terminal board assembly **32** which, as shown in Fig. 1, has a number, for example four, terminals **32.1**. These terminals are hollow as indicated at **32.5**, permitting a wire to be threaded therethrough and soldered thereto from the outside thereof.

A retaining spring ring **35** is inserted in the recess **21.11** in conventional manner, as indicated in Figs. 1 and 2.

In this embodiment of the invention, the spindle **25** with slug **24** is fixed relatively to the housing **21** by means of a lock nut **25.1** which serves for tightening the hemispherical portion **21.22** on the spindle **25**, by means of the slits **21.23** which reach somewhat into the threaded portion of the spindle region **21.2**, the lip **25.2** of the lock nut **25.1** serving to compress the slotted hemispherical portion **21.22** when the lock nut is tightened. The core **24** is adjusted by means of rotating the slotted spindle **25** with a simple tool. After adjustment, the core is set in position by means of tightening the lock nut **25.1** as above described.

The assembly can be mounted on a support such as a panel indicated at **41** of Fig. 2, by means of a lock washer **42** and a nut **43**, likewise shown in Fig. 2.

The housing **21** is conveniently made from brass, the coil form **23** from phenolic resin, the spacers **21.9** and **31** from sponge rubber and the terminal board **32** for example from silicon Fiberglas, with appropriate identification marks such as terminal numerals hot stamped therein if desired. The cup core and cap **28, 29** are made from powdered iron, pressed and sintered in conventional manner.

The above described device is assembled and operated as follows.

These assemblies are usually shipped from the factory with the tuning core **24** on the spindle **25** assembled within the housing **21**, whereas the parts that go into the shell portion **21.1** are furnished in bulk.

Before completely assembling the device, the impedance element is applied, such as by winding a wire on the coil form **23**.

If outside assembly of form and cup core is not desired, the completed coil form is inserted into the cavity **21.4** of the stud portion **21.2** of the housing **21**, with the lower end of the form resting at the conical bottom of the cavity with the washer **21.9** inserted in the shell on the shoulder **21.8**, as indicated in Fig. 2. The upper end of the form extends into the chamber of the shell portion **21.1**. The cup core can then be filled with impregnant as required according to conventional techniques.

If it is desired to pot the coil assembly outside of the shell, for example for the purpose of baking it to properly cure the impregnant, various expedients are feasible, for example the following one. The coil form with the winding on it is inserted into the powder metal cup core by means of a jig which has a plurality of raised portions corresponding in shape to that of the cup core cap **29**, thus properly positioning the form within the cup. By means of an eye dropper, some adhesive agent such as available under the trade designation "Epoxy" is then applied to the gap between the cup core and the form, and permitted to cure. These Epoxy materials, well known at this time, are resin polymers that together with a curing agent such as a catalyst or cross-linking agent set at room temperature within about one hour, and completely fill a gap due to their surface tension properties. The subassembly of form and cup can then be handled in any desirable fashion, and since the gap therebetween is sealed, the impregnant is with safety confined in the void between the coil and cup core during filling as well as baking.

Care has to be taken in all cases not to allow any of the impregnating compound to become deposited on the inside of the form since this would impair movement of the tuning core. This however is effectively prevented by the above described sealing technique or one similar thereto.

No matter how the shell, the coil form and the cup core are assembled the cup core cap **29** is then put on and then the sponge rubber spacer **31**, care being taken to orient the coil leads to pass through the notches of **29** and **31** (Figs. 5 and 6) and to mate them correctly with the terminals when the terminal assembly **35** is finally put on. The core leads are left extending through the cup core notches at least one inch for easy insertion through the terminals. They are then stripped and tinned to within about one-eighth of an inch of the cup core.

The coil leads are threaded through the terminals of the terminal board, through the holes **32.5** indicated in Figs. 1 and 2 and the terminal board is then placed over the spacer **31**. The terminal board is pressed down to compress the spacers, and the retaining ring **35** is inserted into the groove **21.11**. The bent ends protrude, as shown in Fig. 1, through the housing notch **21.24** which also accommodates the key **32.7** of the terminal board.

The leads can then be soldered to the terminals in conventional manner or otherwise connected.

It will be evident that the terminal assembly can be furnished with any desired number of terminals, four being shown in the present embodiment.

The embodiment according to Figs. 7 and 8 is in principle similar to that above described, with the following modifications.

Instead of holding the assembly together by means of a spring ring such as component **35** of Figs. 1 and 2, a cap **51** with slots **51.1** is sometimes preferable. This cap is slightly collapsed after slotting so that it fits snugly on the shell outside diameter. For permanent assembly the cover can be secured to the shell with a dot of solder indicated at **52** of Fig. 8. This construction has the advantage that the assembly can be provisionally secured

without the use of any tool whatsoever and can then be permanently fixed without any danger of a confining member such as spring **35** becoming detached.

Fig. 8 also indicates a somewhat different embodiment of the form **53**, which has in this instance flanges **53.1**, **53.2** for better confining a winding, for example of very fine wire. In this instance the cup core cap **59** can be flat on both sides.

Fig. 8 also indicates another mode of fixing the adjustable core member **24** with its spindle **25**, by means of a torsion spring ring member **62** on a neck portion **27** of the stud portion **61.2** of the housing **61** with its shell portion **61.1**. In this instance the outside thread of the stud end **61.2** is somewhat wider than the spring ring **62**, so that a mounting washer **42** and a nut **43** can be inserted over the end of the stud portion with the spindle **25** protruding therefrom.

This embodiment lends itself especially well for providing a grounding terminal for the assembly as a whole. For this purpose a tab **65** is stamped from the metal for the cap **51** and bent upwardly as indicated in Fig. 8.

It will now be evident that the above described construction provides a firm and positive support for the form **23**, in the cavity **21.4** and at the same time permits complete withdrawal of the core **24** from the cup core **28**, **29** thus permitting a wider range of adjustment. It will be further apparent that the stud portion **21.2** not only provides the above mentioned cavity for better securing the form and for fully withdrawing the adjustable core but also has the function of a mounting member by way of its outside thread **21.21**. This construction thus provides unusually versatile and yet compact and simple construction, due to this triple function of the stud portion **21.2** of the housing **21**.

It will be also apparent that the unobstructed outside of the chamber portion of the housing shell **21.1** permits the use of a spring ring such as **35** of Figs. 1 and 2 alternatively with that of a slotted cap as shown in Figs. 7 and 8, since it is possible to use a housing according to Figs. 1 and 2, provided with the annular recess **21.11**, also with a cap **51**, according to requirements.

It will be further apparent that the assembly according to the present invention is unusually well shielded electrically and is particularly well suited for applications that require miniature size, a rugged and shock resistant construction and a mechanically enclosed and thus fully protected coil.

The construction according to Fig. 8, with a cap **51** having a grounding tab **65**, lends itself especially well for mounting on a printed circuit panel such as indicated at **40** of Fig. 8. In this instance the terminals **32** and the tab **65** are inserted into perforations of the panel **40** and the protruding ends dip soldered thereto in conventional manner. It will be evident that the stud mounting means such as the outside thread of the stud portion, for the washer **42** and the nut **43**, can then be omitted.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

We claim:

1. A tunable impedance device of the type having an adjustable core member, comprising: smoothly tubular form means; a housing which has at one end stud means with fastening means on the outside and with a cavity that fits said form means, and which housing has at the other end integrally therewith a chamber that is wider than said form means, said cavity being contracted at the extreme end of the stud means and communicating on the opposite end with said chamber with a shoulder, said form means extending from said cavity into said chamber; in said chamber a cup-shaped core with its bottom resting on said shoulder and having in said bottom an opening for said form means, the clearance between said core and said form means accommodating

a winding; a disk-shaped core cap fitting into the open end of said cup-shaped core and resting on said form means; loosely inserted into said chamber elastic washer means extending over both core and core gap; means including a terminal board secured to the outer end of said chamber for compressing and confining said core, core cap, and washer means; and axially threaded into said extreme end of said stud means and penetrating into the space within said form means, a spindle for carrying said core member and for axially adjusting it within said form means; whereby said core means can be substantially fully withdrawn from the chamber region of said form means into its stud cavity region, such as essentially to disassociate said core means from said chamber.

2. A tunable impedance device of the type having an adjustable core member, comprising: tubular form means; a metal housing which has at one end a stud portion with mounting means on the outside and with a cavity snugly fitting said form means along a portion long enough substantially to receive said core member and which housing has at the other end a shell portion integral therewith with a chamber that is wider than said form means, said cavity being contracted at the extreme end of the stud portion and leading on the opposite end of the stud portion with a shoulder into said chamber, and said form means extending from said cavity into said chamber where it has a peripheral clearance to accommodate an impedance element; within said chamber a cup shaped iron core member placed with its bottom resting on said shoulder; a terminal board member fitting

the inside of said chamber; resilient plate means arranged adjacent to said cup core member; means for holding said cup core member, said terminal board member and said resilient plate means under compression within said chamber; and, attached at said contracted extreme end of said stud means and extending into the space within said form means, means for carrying said core member and for axially adjusting it within said form means; whereby the core means can be substantially fully withdrawn from the shell chamber region of the form means into its stud cavity region, such as essentially to disassociate the core means from the chamber, and the form means, cup core member, plate means and terminal board member are firmly and compactly confined within the chamber.

3. Device according to claim 2 wherein said holding means includes an annular recess on the inside of said chamber near the outer rim of the shell portion, and a spring ring inserted therein.

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