United States Patent [19]

Harwood

[11] **3,781,723**

[45] **Dec. 25, 1973**

[54] **COATED FERRITE FILTERS HAVING STAMPED AND FORMED OUTER SLEEVES**

[75] Inventor: **Robert George Harwood,** Mechanicsburg, Pa.

[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

[22] Filed: **Jan. 21, 1972**

[21] Appl. No.: **219,817**

[52] **U.S. Cl.** **333/79,** 339/128

[51] **Int. Cl.** **H01h 7/14**

[58] **Field of Search** 333/79; 339/128

[56] **References Cited**

UNITED STATES PATENTS

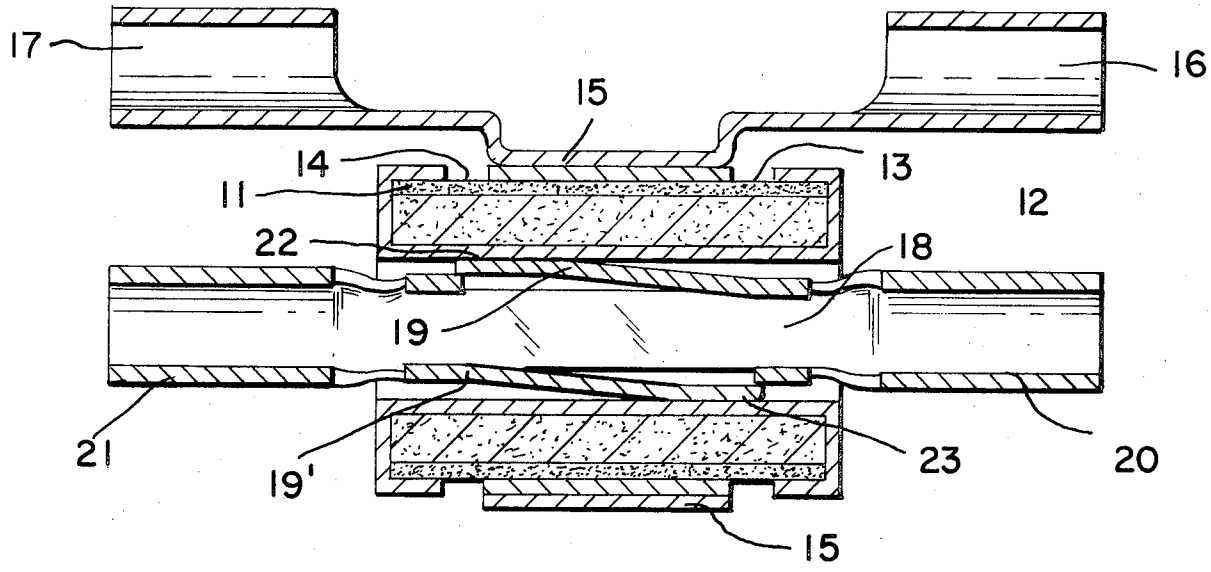
3,588,758	6/1971	Hurst	333/79
3,200,355	8/1965	Dahlen	333/79
3,613,033	10/1971	Denes	333/79
3,539,954	11/1970	Camire	333/79
3,617,958	11/1971	Schor	333/79

Primary Examiner—Rudolph V. Rolinec
Assistant Examiner—Saxfield Chatmon, Jr.
Attorney—William J. Keating et al.

[57] **ABSTRACT**

A lossy filter includes an extruded tube of ferrite with a layer of dielectric such as barium titanate deposited on the outside of the tube. A conductive sleeve is stamped out of sheet metal and die formed around the tube to form an outer sleeve which adds mechanical strength to the filter. Provision of the said outer sleeve permits the use of a high force center contact spring. This center contact spring has a contact section of substantially the same length as the tube. Spring contacts are pivoted from both ends of a contact section, one spring contact located on one side of the contact pin and the other on the other side of the contact pin. The free ends of both spring contacts are deflected when the pin is inserted in the tube to provide opposite high force contacts between the pin and the tube.

8 Claims, 6 Drawing Figures



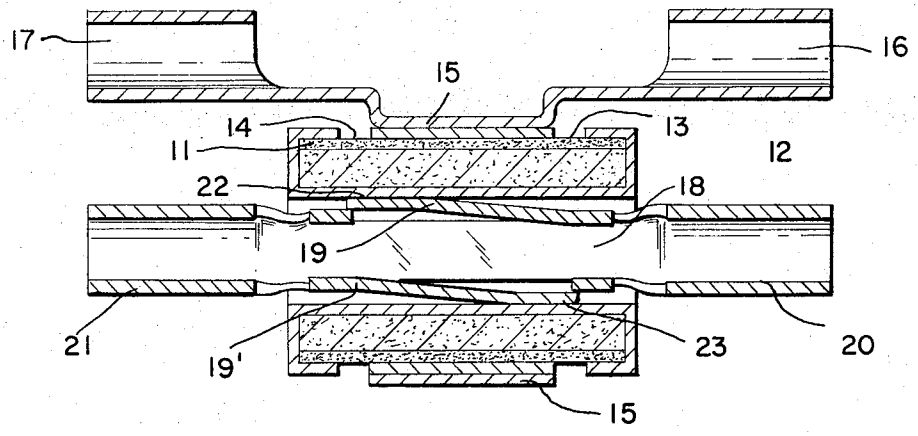


FIG. 1

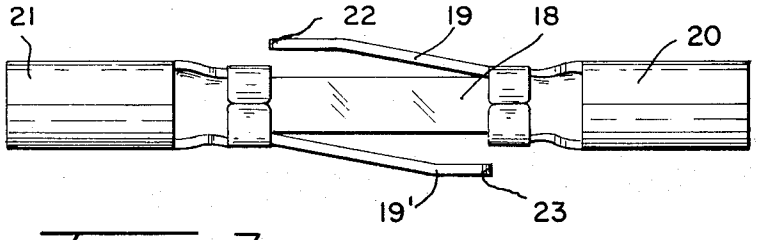


FIG. 2

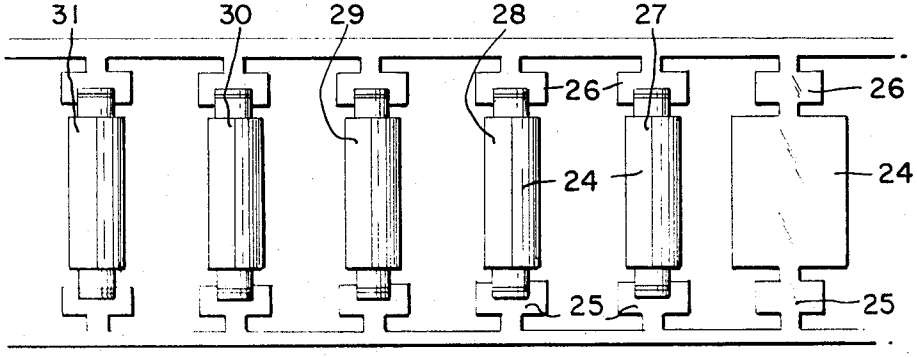


FIG. 3

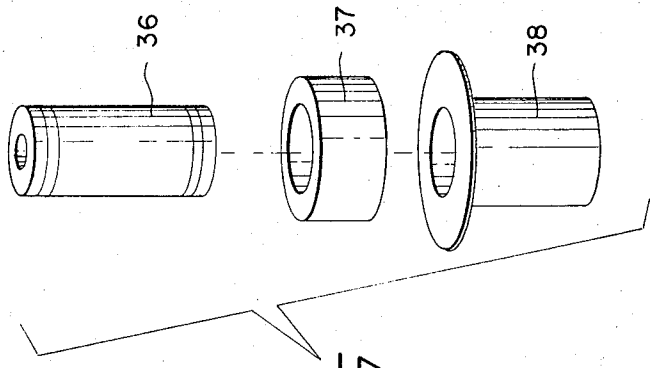


FIG 5

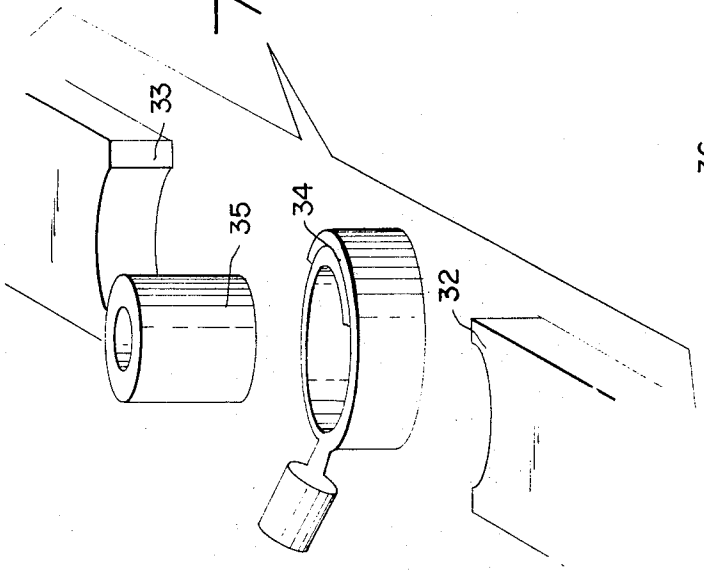


FIG 4

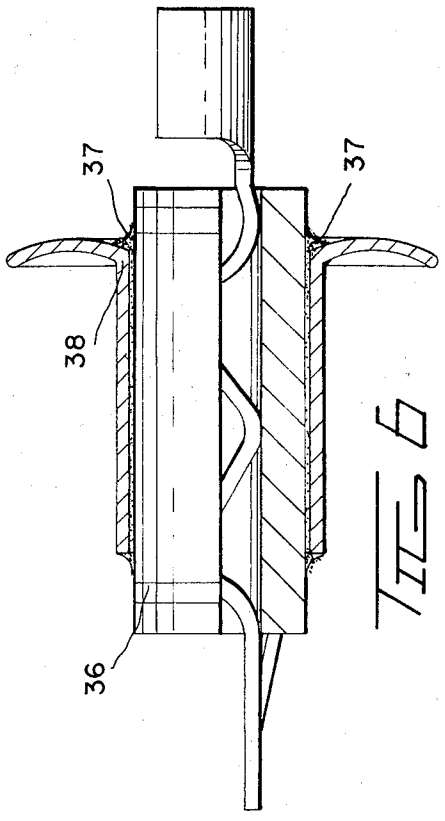


FIG 6

COATED FERRITE FILTERS HAVING STAMPED AND FORMED OUTER SLEEVES

BACKGROUND OF THE INVENTION

This invention relates to improved lossy filter units and more particularly to a filter having a conductive sleeve soldered over a tubular substrate. Low pass RF filters are used extensively in electrical circuits to suppress stray radio frequency noise. RF filters, such as the type shown in the U.S. Pat. No. 3,275,953 to Coda et al, were known to the prior art and have been used as feed-through filters or on connector pins. Such filters are small and have good insertion loss characteristics at high frequencies. However, several problems have arisen with the use of filters of the type shown in the Coda et al, patent.

A much improved form of RF filter unit has been developed and is described in copending patent application Ser. No. 88,042, filed on Nov. 9, 1970, now U.S. Pat. No. 3,743,978, in the name of William B. Fritz, for "Coated Ferrite RF Filter," to which reference is made. The Fritz application is assigned to the assignee of this invention. Filter units of the type disclosed in the Fritz application are constructed of an extruded ferrite tube having a deposited dielectric layer, such as barium titanate thereon. When a connector pin is inserted in the tube, the filter unit serves to filter the electrical signals applied to the connector pin. Because extruded ferrite tubes have good compression strength but poor tensile strength, a high force contact pin cannot be used with this filter unit. Rather, good electrical connections between the pin and the inside of the tube must be established by plating the components with a noble metal, such as silver or gold. Filters such as this are easier to fabricate than prior art type filters, but they are still not completely adapted to automatic application.

SUMMARY OF THE INVENTION

Accordingly, it is an important object of the present invention to provide an improved filter unit having an outer conductive sleeve soldered around the tube of the filter to provide mechanical strength so that a high force contact can be inserted in the tube.

It is another object of the invention to provide a wire connector on the outer conductive sleeve so that the filter unit can be easily used in applications such as the suppression of radio frequencies in household appliances.

It is another object of the invention to provide a filter unit having an outer conductive sleeve adapted to be manufactured in configurations which are easily attached to other metal parts, such as panels, brackets, clips, etc.

It is another object of this invention to provide a filter unit which is easily fabricated by automatic machines and which is produced in easily usable form as strips of filter units suspended between two carriers.

It is another object of this invention to provide a high-force center contact having two deflectable springs which are pivoted from opposite ends of the center section of the contact pin.

It is another object of this invention to produce usable filter units without the necessity of plating the units with a metallic coating.

The foregoing and other objects, features and advantages of the invention will be better understood from the following more detailed description and appended claims.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-section of the improved filter with the high-force center contact pin in place;

FIG. **2** shows the center contact pin;

FIG. **3** shows a strip of filter units;

FIG. **4** depicts the forming dies during the reflow soldering of the sleeve to the filter unit;

FIG. **5** shows a modification; and

FIG. **6** is a cross-section of the FIG. **5** modification.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**, the filter unit includes an extruded ferrite tube **10** coated with the barium titanate layer **11**. The electrophoretic deposition described in Senderoff et al. U.S. Pat. No. 2,843,541, may be used to apply a barium titanate layer to the extruded ferrite tube.

Normally, the device is metal-plated, the metal plating being indicated at **12**. Gaps **13** and **14** in the metal plating isolate the ground and center pin electrodes. Filter units of the type described are the subject matter of the previously mentioned Fritz patent application, Ser. No. 88,042, filed Nov. 9, 1970.

In accordance with the present invention, the conductive sleeve **15** is soldered over the filter unit. This sleeve is stamped from sheet metal and is formed into a ring around the ferrite tube. A protruding section of the sleeve is formed into a wire barrel **16** and at the opposite end another protruding section is formed into another wire barrel **17**. The sleeve **15** serves to maintain the ferrite tube under a compression load and thereby gives the assembly greater strength in tension. These results are obtained in the following manner. Because of the higher coefficient of thermal expansion of the metal sleeve compared to the ferrite material, the outer sleeve contracts more than does the ferrite filter during the cooling period after soldering. Further, the metal sleeve fits exactly against the entire outside surface of the filter unit, due to the solder having filled any clearance spaces between them. Therefore the aforementioned difference in contraction places the metal sleeve in tension and also causes the ferrite filter to be under compression. Although the ferrite filter alone is normally very strong in compression, it is quite weak in tension and is fragile upon impact. Because, as just explained, the sleeve **15** imposes a compression load on the ferrite filter, the assembly of filter and sleeve has much greater strength in tension and much more resistance to breakage.

Because of the added strength, it is possible to use the high force center contact pin shown in FIGS. **1** and **2**. This pin includes a center section **18** which is approximately the same length as the ferrite tube. A contact spring **19** is pivoted from one end of the contact section **18** and a contact spring **19'** is pivoted from the other end of the contact section. Contact springs **19** and **19'** are on opposite sides of the contact pin. When this contact pin is inserted in the hole in the ferrite tube, the springs **19** and **19'** are deflected inwardly to provide a high-force contact between the pin and the tube. In addition, the center contact pin is formed into a wire barrel at each end, as shown at **20** and **21**.

The force which a spring exerts is proportional to its deflection. The deflection which can be obtained with

a spring is proportional to the second power of its length. With the improved contact pin structure of the invention as decribed above, each of the springs **19** and **19'** is given a maximum length, that is they are almost as long as the ferrite tube itself. The extended length is possible because the spring is pivoted from the end of the section **18** which fits in the ferrite tube. Prior connector pins which have been used in filters of this type have been pivoted from both ends. In such cases, the deflectable length was only half as long as the present connector pin, and therefore the deflection obtained was only one fourth as great. As a result, they did not achieve the high contact force and large deflection which are obtained by the subject connector pin.

Each of the springs has a small contact area, as indicated at **22** and **23.** This very small contact area insures that the contact force per unit area is high.

The filter unit of this invention is particularly suitable for suppressing RF frequencies in household appliances. For example, in an appliance the wire barrels **16** and **20** are crimped onto the line cord and the wire barrels **17** and **21** are crimped onto the lead to the appliance on/off switch and to one side of the motor. Connected in this manner, the filter unit provides good suppression of RF frequencies which are particularly troublesome to television reception.

FIG. **3** depicts a number of filter units supported on a carrier strip. Initially, a piece of sheet metal is stamped to form a number of sleeve units. Each sleeve unit includes the flat sleeve portion **24** which will later be formed into the sleeve **15** of FIG. **1** and soldered around the filter unit. Also included are flat wire barrel sections **25** and **26.** These will later be rolled into wire barrels which are the wire barrels **16** and **17** in FIG. **1.**

The filters depicted at **27 – 31** each have the center sleeve portion **24** die formed around the filter tube and the sleeve has been soldered, in place. In this form the filters can be shipped to a customer on a strip. This is a particularly convenient handling technique. The customer who uses the filter in an appliance can easily detach the filter unit from the strip and crimp each of the wire barrel sections around the appropriate conductor.

FIG. **4** depicts forming dies **32** and **33** which wrap the sleeve **34** around the filter tube **35** during reflow soldering. In the embodiment being depicted here the sleeve **34** is a stamped and formed soldered ring. Normally, an infrared lamp is used to heat the solder. The dies may take the form of the cooled anvil which comes down onto the sleeve and cools the solder. As depicted in FIG. **4,** the filter unit **35** does not have the metallic plating **12** thereon. It is possible to use an unplated filter unit because the solder is pressed onto the barium titanate so as to obtain a good mechanical flow of solder which will make an electrical connection to the barium titanate. This is a particularly attractive alternative because it eliminates the requirement of banding the conductive coating to obtain the gaps **13** and **14** shown in FIG. **1.**

FIGS. **5** and **6** depict another modification of the invention. In this case a plated filter **36** is inserted in a solder preform **37** and a metal grommet **38.** The solder is heated to form a bond between the plated filter **36** and the metal grommet **38.** Again, the grommet serves as an outer support sleeve to maintain the filter unit in compression. This allows the use of the high-force center contact pin of FIG. **2.** Also, the sleeve provides a good connection for the ground plane.

In prior art type filters it was generally required to plate the filter unit with a noble metal such as gold or silver. This was required to obtain a good electrical connection between the connector pin and the inside of the filter unit. However, when the compression sleeve **15, 34,** or **38** of this invention is used, it is possible to use a high-force center connector pin and thereby obviate the requirement for the noble metal plating on the filter unit. While particular embodiments have been shown and described, various modifications will be apparent. The appended claims are intended to cover all such modifications within the true spirit and scope of the invention.

What is claimed is:

1. A tubular lossy filter for receiving a contact pin therein,

said filter comprising a tubular substrate provided with an exterior layer of dielectric material thereon and which is normally weak in tension and fragile upon impact,

sheet metal sleeve means about the outer surface of the filter in close fitting engagement therewith to apply radially compressive forces thereto, the contact pin received therein including conductive resilient means extending radially outwardly therefrom into forcible engagement with the interior surface of the filter to apply forces thereto which are in a direction substantially opposite to that of said compressive forces.

2. A tubular lossy filter according to claim **1** wherein the exterior surface of the dielectric layer is provided with a conductive coating to which the sheet metal sleeve is secured by solder.

3. A tubular lossy filter according to claim **1,** wherein said sleeve means is provided with lead securing means thereon.

4. A tubular lossy filter according to claim **1,** wherein the interior surface of the tubular filter is provided with a conductive coating against which the resilient means bears.

5. A tubular lossy filter according to claim **1,** wherein the resilient means includes at least one elongated spring finger secured at one end to the pin at a location substantially adjacent one end of the sleeve with the free end of the finger bearing against the interior surface of the filter at a location adjacent the opposite end of the sleeve to apply tensile forces thereto.

6. A tubular lossy filter according to claim **5,** wherein a further elongated spring finger is secured at one end to the pin at a location which is substantially at the opposite end of the sleeve with its free end bearing against the interior surface of the filter at a location adjacent the one end of the sleeve for applying tensile forces against the tubular filter.

7. A tubular lossy filter according to claim **6,** wherein the interior surface of the tubular filter is provided with a conductive coating against which the free end of the spring finger bears.

8. A tubular lossy filter according to claim **6,** wherein the interior surface of the filter is provided with a conductive coating against which the free ends of the spring fingers bear.

* * * * *