

Description

The present invention relates to a capacitor for surface mounting on a substrate in an electronic circuit.

As the technology of surface mounting electronic components to substrates continues to gain acceptance in today's marketplace and continues to find preference over through-hole circuit board assembly, ceramic multi-layer capacitors are increasing in popularity at the expense of polymer dielectric capacitors.

A conventional dielectric multilayer capacitor which has been modified for surface mounting on a substrate is illustrated in EP-A 0130386 and corresponding US-A 4578737. This capacitor comprises a flattened metallised plastics film wound capacitor body having leads formed of conducting sheet material soldered or welded onto Schoop-layers on its opposite ends. The body and the part of the leads connected to the body are then encapsulated in a thermosetting resin material and the leads wrapped around the outside of the encapsulating coating to form pads by which the capacitor is soldered onto a printed circuit board. The sheet material has a thickness of from 0.1 to 0.5 mm so that a substantial gap is formed between the capacitor body and the substrate. Prior art attempts to adapt plastic film capacitors to surface mounting techniques, involve the provision of bulky thermal protection structures such as encapsulation and a fair leading of electrical access terminals from the capacitor terminals within the thermally protected package to a point outside the thermally protected package to which connection is made when using the device in an electronic circuit. Typically, such thermally protectively packaged plastic film capacitors are uni-directional in their applicability. That is, such capacitors can only be mounted in a particular attitude and, if that attitude is not presented to the substrate, no effective electrical connection can be made. Such capacitors have a «top» and a «bottom» and if they are, for instance by some automated handling means, presented «upside down» for connection to a substrate in a production assembly operation, no electrical connection may be effected with the capacitor.

Ceramic multi-layer capacitors, if not thermally shocked, withstand high temperature solder assembly techniques to substrates. In such high temperature solder assembly situations, a ceramic multi-layer capacitor's value shifts upward with the temperature rise during soldering and then exponentially decays over a period of days with the rate of decay depending upon the specific ceramic body involved. Ceramic capacitors, are subject to extremely high temperatures during their manufacture, and do not require an insulated overcoat to protect them thermally so that they are small and their cost is kept low.

The present configuration of ceramic capacitors as they are adapted for surface mounting applications in the electronics industry has distinct short-

comings. One such shortcoming is the electrical terminal connection points presently used with ceramic multi-layer capacitors in surface mounted applications.

Presently available ceramic multi-layer capacitors configured for surface mounting applications have terminal arrangements which, when the capacitor is in assembled relation with a substrate upon which it is mounted, maintain the body of the capacitor only slightly above the level of the substrate itself.

This arrangement causes at least two major problems: first, the extremely narrow gap between the body of the capacitor and the substrate to which it is mounted makes it very difficult to flush out contaminants such as solder flux and the like which commonly accumulate during processing of electronic circuits in production volume operations. Second, and closely allied with the difficulty in flushing contaminants from between the capacitor body and the substrate, is the problem that since the contaminants are generally inadequately flushed and therefore remain trapped between the capacitor and the substrate, there is thereby provided a leakage path across the capacitor terminals which can severely affect the performance of a capacitor within the circuit in which it is employed.

It is well known in the electronics industry that polymer dielectric capacitors, commonly known as plastic film capacitors, enjoy some important advantages over ceramic multi-layer capacitors. For example, insulation resistance, a measure of the capacitor's resistance to providing a leakage path, is generally higher with plastic film capacitors than with similarly valued and dimensioned ceramic multi-layer capacitors.

Further, the dissipation factor, a factor relating to the dissipation of energy by a capacitor, is generally lower with plastic film capacitors than with similarly valued and dimensioned ceramic multi-layer capacitors.

Of perhaps the greatest importance is the capability of plastic film capacitors to self-heal in the event of a short circuit. Plastic film capacitors are coated with thin metal electrodes (generally aluminium) which electrodes vaporize at a shorted area to instantly clear the short and self-heal. Ceramic multi-layer electrodes are thick film and will not vaporize and clear. As a result, the ceramic multi-layer parts, when shorted, can dissipate a large amount of energy, which energy is sometimes manifested as heat sufficient to start fires within equipment.

Thus, it would be of extreme value to the electronic industry if a plastic film capacitor, with all of its advantages over ceramic multi-layer capacitors, could be produced in a manner to render it compatible with today's surface mounting techniques.

According to this invention a metallized film capacitor for surface mounting on a substrate, has a leadless configuration in which its unencapsulated capacitive structure is electrically terminated at one end by a first sprayed on electrical termina-

tion and at the other end by a second sprayed on electrical termination, both the first and second sprayed on electrical terminations being of material compatible with metallic material in the capacitive structure, the capacitive body having a lateral face between the ends, and sprayed on extensions of solderable material connected to each of the first and second electrical terminations and extending onto the lateral face, the extensions having sufficient thickness to establish a gap between the lateral face and the substrate when the capacitor is surface mounted on the substrate; the surface mounting being effected by the extensions and the gap being sufficient to facilitate removal of contaminants from between the lateral face and the substrate after mounting.

When a capacitor in accordance with this invention is mounted on a substrate in an electronic circuit, a substantial gap is formed between the capacitor body and the substrate to which it is mounted, typically of the order of 0.005 inches, (12.5 μm) which greatly facilitates the flushing of contaminants from between the capacitor body and the substrate after processing, thereby greatly reducing the tendency of trapped contaminants to provide a leakage path across the terminals of the capacitor.

No presently extant application of plastic film dielectric capacitors to surface mounting techniques is known except for specially packaged, bulky devices incorporating thermally protective encasement techniques such as plastic boxes or bulky wrappings.

Preferably the extensions extend on both the top and bottom lateral face of the conductive body. In this case the capacitor of the preferred embodiment of the present invention, in contrast, has no «top» or «bottom»; it is multi-directional, and therefore it is more easily handled by automated assembly machinery, which results in a lower cost of manufacture of circuits involving capacitors of the type disclosed herein.

Significant savings in cost of manufacture over other surface mountable plastic film capacitors are realized.

Particular examples of a capacitor in accordance with this invention will now be described with reference to the accompanying drawings; in which:

Fig. 1 is a perspective view;

fig. 2 is a perspective view of an alternate example; and

fig. 3 is a side elevation of the capacitor installed upon a substrate.

Referring to fig. 1, a plastic film capacitor 10 is illustrated. The capacitor 10 has a parallel plate structure 12 comprised of alternating layers of plastic dielectric film and electrically conductive material (not shown). The parallel plates 12 are connected at a first electrical terminal 14 and a second terminal 16 in a manner creating a capacitive relationship among the parallel plates 12.

In the preferred embodiment of the present invention the parallel plate structure 12 is protected by an additional, relatively thick, top cover plate

18 and bottom cover plate 20, which cover plates 18 and 20 are preferably comprised of plastic material similar in composition to the plastic dielectric film of the parallel plate structure.

According to the preferred embodiment of the present invention, as illustrated in fig. 1, associated with the first electrical terminal 14 are a top electrical termination pad 22 and a bottom electrical termination pad 24. Similarly associated with the second electrical terminal 16 are a top electrical terminal pad 26 and a bottom electrical terminal pad 28.

In the preferred embodiment of the present invention, the parallel plate structure 12 is comprised of plastic film material having deposited thereon a thin film of aluminum.

In order that there be no dissimilar metal coupling between the electrical terminals 14 and 16 and the metallized film of the parallel plate structure 12, it is preferable that the electrical terminals 14 and 16 be comprised of aluminum as well.

Aluminum is not receptive to solder and therefore prior art devices have accomplished attachment of solderable leads to the electrical terminals such as 14 and 16 of fig. 1 in order to facilitate soldering connection of the capacitor within an electronic circuit. However, the invention herein disclosed is intended for surface mounting (leadless mounting) within electronic circuits. Therefore, the electrical terminal pads 22, 24, 26 and 28 are added, generally by a spraying technique, in order to provide leadless solderable access to the parallel plate structure 12 of the capacitor via electrical terminals 14 and 16.

Thus, for example, electrical terminal pads 22 and 26 are sprayed copper applied to the top of the capacitor 10. Electrical terminal pad 22 spans electrical terminal 14 and a portion of top cover plate 18; electrical terminal pad 26 spans electrical terminal 16 and a portion of top cover plate 18. Similarly, electrical terminal pad 24 spans electrical terminal 14 and a portion of bottom cover plate 20; electrical terminal pad 28 spans electrical terminal 16 and a portion of bottom cover plate 20.

In the preferred embodiment, the electrical terminal pads 22, 24, 26 and 28 are comprised of copper and are applied by hot spraying techniques generally known in the electronics industry. A beneficial consequence of this hot spraying application technique and the positioning of electrical terminal pads 22, 24, 26 and 28 spanning an electrical terminal 14, 16 and extending onto a cover plate 18 or 20, is that when the hot copper particles strike the cover plate they become partially embedded in the cover plate, providing a firm bond between the copper and the cover plate. The aluminum spray material which comprises the electrical terminals 14 and 16 is porous in its final form and consequently the spray copper infiltrates well within the porous aluminum and provides the electrical terminal pads 22, 24, 26 or 28 a firm bond with the aluminum porous material of the electrical terminals 14 and 16 as well. Thus, each respective electrical terminal pad 22, 24, 26 and 28 is firmly anchored both to its respective

terminal 14 or 16 and to its respective cover plate 18 or 20. This firm bonding spanning relationship among the cover plates 18 and 20 and the electrical terminals 14 and 16 significantly enhances the physical integrity of the capacitor 10 and its resistance to delamination.

In fig. 1, the preferred embodiment is illustrated wherein the electrical terminal pads 22, 24, 26 and 28 do not cover the end faces of the electrical terminals 14 and 16 so that in surface mounting the solder adhesion of the capacitor to the substrate to which it is mounted will be concentrated on the two electrical terminal pads (22 and 26 or 24 and 28) by which it contacts circuit traces on that substrate. Of course, the electrical terminal pads 22 and 24 could be extended to meet and cover the end face of electrical terminal 14 and the electrical terminal pads 26 and 28 could be extended to meet and cover the end face of electrical terminal 16.

While the materials suggested for the preferred embodiment of the invention hereinabove include aluminum and copper, certainly other materials known in the art to have appropriate properties for establishment of capacitive structure and solderability could as well be used.

A significant feature of the structure illustrated in fig. 1 and contemplated by this disclosure is illustrated in fig. 3. Fig. 3 illustrates in side schematic view the installation of a capacitor 10 upon a substrate 30.

For purposes of clarity of understanding the invention, like elements will be given the same reference numeral in the various views incorporating those elements.

In fig. 3 the capacitor 10 is mounted upon the substrate 30 by electrical terminal pads 24 and 28 making electrical connection respectively to substrate pads 32 and 34. Substrate pads 32 and 34 are intended to represent connection points within circuitry (not shown) carried upon the substrate 30. A significant structural feature of the present invention, best illustrated by fig. 3, is the fact that when the capacitor 10 is mounted upon the substrate 30 by its substrate pads 32 and 34 and the capacitor's electrical termination pads 24 and 28, the capacitor clears the top 36 of the substrate 30 by a distance D established between the top 36 of the substrate 30 and the bottom plate 20 of the capacitor 10.

In the preferred embodiment of the present invention, the distance D between the top 36 of the substrate 30 and the bottom cover plate 20 of the capacitor 10 is on the order of 0.005 inches (12.5 μ m); that distance is significantly greater than is presently available with either ceramic or other plastic film surface mounted type capacitive devices and serves to greatly facilitate the flushing of contaminants from between the capacitor 10 and the substrate 30 after the capacitor 10 is mounted by surface mounting means upon the substrate 30. Failure to adequately flush such contaminants, which may be solder flux or the like, from between the capacitor 10 and the substrate 30 provides an

opportunity for a leakage path to be established across the substrate pads 32 and 34, thereby shorting out the capacitor 10 and rendering the electronic circuit in which it is employed inoperable.

Referring to fig. 2, an alternate embodiment of the present invention is illustrated wherein there is a capacitor 40. The capacitor 40 of fig. 2 is contemplated to be a plastic film dielectric capacitor of the type wherein the plates of the capacitor are formed by concentric winding upon a mandrel or by similar means so that a substantially cylindrical capacitor is formed. The substantially cylindrical capacitor is then flattened to the ovate cross-sectioned shape illustrated in fig. 2. The capacitor 40 is then coated at its ends with electrical terminals 42 and 44 and thereafter electrical terminal pads 46, 48, 50 and 52 are applied to span the electrical terminals 42 and 44 and extend onto a portion of lateral face 54 of the capacitor 40.

For the same reasons as hereinbefore recited with regard to fig. 1, the electrical terminals 42 and 44 are preferably of aluminum in order that no dissimilar metal reaction will occur between the electrical terminals 42 and 44 and the electrical plate material of the plate structure of the capacitor 40. Similarly, the electrical terminal pads 46, 48, 50 and 52 are preferably comprised of copper which is hot spray applied in order that the hot copper material will embed itself into the material of lateral face 54 and infiltrate the porous structure of the electrical terminals 42 and 44, thereby enhancing the physical integrity of the capacitor 40 and increasing its resistance to disassembly.

Likewise, as in the embodiment illustrated in fig. 1, the above recited materials are preferred materials and other materials could be used without straying from the scope of the invention disclosed herein.

The thickness of electrical terminal pads 46, 48, 50 and 52, as discussed in the embodiment illustrated by fig. 2, should be of sufficient thickness to provide a standoff distance from a substrate when the capacitor 40 is installed by surface mounting methods to facilitate flushing of contaminants from between the capacitor 40 and its associated substrate upon which it is mounted.

Claims

1. A metallized-film capacitor (10, 40) for surface mounting on a substrate (30), the capacitor having a leadless configuration in which its unencapsulated capacitive structure (12, 54) is electrically terminated at one end by a first sprayed-on electrical termination (14, 42) and at the other end by a second sprayed-on electrical termination (16, 44), both the first (14, 42) and second (16, 44) sprayed-on electrical terminations being of material compatible with metallic material in the capacitive structure (12, 54), the capacitor having a lateral face between the ends and sprayed-on extensions (22, 24, 26, 28, 46, 48, 50, 52) of solderable material or each of the first (14, 42) and second (16, 44)

terminal 14 or 16 and to its respective cover plate 18 or 20. This firm bonding spanning relationship among the cover plates 18 and 20 and the electrical terminals 14 and 16 significantly enhances the physical integrity of the capacitor 10 and its resistance to delamination.

In fig. 1, the preferred embodiment is illustrated wherein the electrical terminal pads 22, 24, 26 and 28 do not cover the end faces of the electrical terminals 14 and 16 so that in surface mounting the solder adhesion of the capacitor to the substrate to which it is mounted will be concentrated on the two electrical terminal pads (22 and 26 or 24 and 28) by which it contacts circuit traces on that substrate. Of course, the electrical terminal pads 22 and 24 could be extended to meet and cover the end face of electrical terminal 14 and the electrical terminal pads 26 and 28 could be extended to meet and cover the end face of electrical terminal 16.

While the materials suggested for the preferred embodiment of the invention hereinabove include aluminum and copper, certainly other materials known in the art to have appropriate properties for establishment of capacitive structure and solderability could as well be used.

A significant feature of the structure illustrated in fig. 1 and contemplated by this disclosure is illustrated in fig. 3. Fig. 3 illustrates in side schematic view the installation of a capacitor 10 upon a substrate 30.

For purposes of clarity of understanding the invention, like elements will be given the same reference numeral in the various views incorporating those elements.

In fig. 3 the capacitor 10 is mounted upon the substrate 30 by electrical terminal pads 24 and 28 making electrical connection respectively to substrate pads 32 and 34. Substrate pads 32 and 34 are intended to represent connection points within circuitry (not shown) carried upon the substrate 30. A significant structural feature of the present invention, best illustrated by fig. 3, is the fact that when the capacitor 10 is mounted upon the substrate 30 by its substrate pads 32 and 34 and the capacitor's electrical termination pads 24 and 28, the capacitor clears the top 36 of the substrate 30 by a distance D established between the top 36 of the substrate 30 and the bottom plate 20 of the capacitor 10.

In the preferred embodiment of the present invention, the distance D between the top 36 of the substrate 30 and the bottom cover plate 20 of the capacitor 10 is on the order of 0.005 inches (12.5 μ m); that distance is significantly greater than is presently available with either ceramic or other plastic film surface mounted type capacitive devices and serves to greatly facilitate the flushing of contaminants from between the capacitor 10 and the substrate 30 after the capacitor 10 is mounted by surface mounting means upon the substrate 30. Failure to adequately flush such contaminants, which may be solder flux or the like, from between the capacitor 10 and the substrate 30 provides an

opportunity for a leakage path to be established across the substrate pads 32 and 34, thereby shorting out the capacitor 10 and rendering the electronic circuit in which it is employed inoperable.

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For the same reasons as hereinbefore recited with regard to fig. 1, the electrical terminals 42 and 44 are preferably of aluminum in order that no dissimilar metal reaction will occur between the electrical terminals 42 and 44 and the electrical plate material of the plate structure of the capacitor 40. Similarly, the electrical terminal pads 46, 48, 50 and 52 are preferably comprised of copper which is hot spray applied in order that the hot copper material will embed itself into the material of lateral face 54 and infiltrate the porous structure of the electrical terminals 42 and 44, thereby enhancing the physical integrity of the capacitor 40 and increasing its resistance to disassembly.

Likewise, as in the embodiment illustrated in fig. 1, the above recited materials are preferred materials and other materials could be used without straying from the scope of the invention disclosed herein.

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Claims

1. A metallized film capacitor (10, 40) for surface mounting on a substrate (30), the capacitor having a leadless configuration in which its unencapsulated capacitive structure (12, 54) is electrically terminated at one end by a first sprayed-on electrical termination (14, 42) and at the other end by a second sprayed-on electrical termination (16, 44), both the first (14, 42) and second (16, 44) sprayed-on electrical terminations being of material compatible with metallic material in the capacitive structure (12, 54), the capacitor having a lateral face between the ends and sprayed-on extensions (22, 24, 26, 28, 46, 48, 50, 52) of solderable material of each of the first (14, 42) and second (16, 44)



electrical terminations and extending onto the lateral face, the extensions (22, 24, 26, 28, 46, 48, 50, 52) having sufficient thickness to establish a gap between the lateral face and the substrate (30) when the capacitor (10, 40) is surface mounted on the substrate; the surface mounting being effected by the extensions (22, 24, 26, 28, 46, 48, 50, 52) and the cap being sufficient to facilitate removal of contaminants from between the lateral face and the substrate (30) after mounting.

2. A capacitor according to claim 1, wherein the first (14, 42) and second (16, 44) sprayed-on electrical terminations are limited in a translateral dimension to be substantially coterminous with the lateral face.

3. A capacitor according to claim 1 or 2, wherein the material forming the first and second electrical termination is aluminum and the material forming the extensions is copper.

4. A capacitor according to any one of the preceding claims, wherein the capacitor (10, 40) includes two lateral faces defining a top and a bottom, and the extensions (22, 24, 26, 28, 46, 48, 50, 52) are located on both lateral faces forming the top and bottom.

4. A capacitor according to any one of the preceding claims, wherein the capacitive structure (12) comprises plurality of parallel plates; four lateral sides defining a top, a bottom, a first side, a second side; a first end, and a second end, the first electrical termination (14) being formed on the first end, and the second electrical termination (16) being formed on the second end.

Patentansprüche

1. Kondensator (10, 40) aus metallisiertem Film zur Montage auf der Oberfläche eines Substrats (30), gekennzeichnet durch eine zuleitungslose Ausführung, in welcher der eingekapselte Kondensatoraufbau (12, 54) an einem Ende durch einen ersten aufgesprützten elektrischen Anschluß (14, 42) und an dem anderen Ende durch einen zweiten aufgesprützten elektrischen Anschluß (16, 44) mit elektrischen Anschlüssen versehen ist, wobei der erste (14, 42) und zweite (16, 44) aufgespritzte elektrische Anschluß aus Werkstoff besteht, der kompatibel mit metallischem Werkstoff in dem Kondensatoraufbau (12, 54) ist, wobei der Kondensator eine Seitenfläche zwischen den Enden und aufgespritzte Ansätze (22, 24, 26, 28, 46, 48, 50, 52) aus lötbarem Werkstoff der ersten (14, 42) und zweiten (16, 44) elektrischen Anschlüsse aufweist, wobei die Ansätze sich auf der Seitenfläche erstrecken, wobei die Ansätze (22, 24, 26, 28, 46, 48, 50, 52) eine genügende Dicke aufweisen, um eine Lücke zwischen der Seitenfläche und dem Substrat (30) zu bilden, wenn der Kondensator (10, 40) auf der Oberfläche des Substrats montiert wird, wobei ferner die Oberflächenmontierung durch die Ansätze (22, 24, 26, 28, 46, 48, 50, 52) bewirkt wird und die Lücke ausreicht, um das Entfernen von Verunreinigungen zwischen der Seitenfläche und dem Substrat (30) nach der Montierung zu erleichtern.

2. Kondensator nach Anspruch 1, dadurch gekennzeichnet, daß die ersten (14, 42) und zweiten (16, 44) aufgesprützten elektrischen Anschlüsse in ihrer seitlichen Ausdehnung begrenzt sind, um im wesentlichen mit der Seitenfläche abzuschließen.

3. Kondensator nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Werkstoff, der die ersten und zweiten elektrischen Anschlüsse bildet, Aluminium ist und der Werkstoff, der die Ansätze bildet, Kupfer ist.

4. Kondensator nach einem der vorangegangenen Ansprüche, dadurch gekennzeichnet, daß der Kondensator (10, 40) zwei Seitenflächen aufweist, die eine obere Fläche und einen Boden bilden, und die Ansätze (22, 24, 26, 28, 46, 48, 50, 52) auf beiden Seitenflächen; die die obere Fläche und den Boden bilden, angeordnet sind.

5. Kondensator nach einem der vorangegangenen Ansprüche, dadurch gekennzeichnet, daß der Kondensatoraufbau (12) eine Vielzahl von parallelen Platten aufweist, vier Seitenflächen, die eine obere Fläche, einen Boden, eine erste Seite, eine zweite Seite bilden, ein erstes Ende und ein zweites Ende, wobei der erste elektrische Anschluß (14) an dem ersten Ende gebildet ist und der zweite elektrische Anschluß (16) an dem zweiten Ende gebildet ist.

Revendications

1. Condensateur (10, 40) à film métallisé à monter en surface sur un substrat (30), le condensateur ayant une configuration sans fil dans laquelle sa structure capacitive non enrobée (12, 54) est terminée électriquement, à une première extrémité, par une première terminaison électrique (14, 42) appliquée par projection et, à l'autre extrémité, par une seconde terminaison électrique (16, 44) appliquée par projection, les deux première (14, 42) et seconde (16, 44) terminaisons électriques appliquées par projection étant en une matière compatible avec la matière métallique de la structure capacitive (12, 54), le condensateur ayant une face latérale entre les extrémités et des prolongements (22, 24, 26, 28, 46, 48, 50, 52), appliqués par projection, en matière soudable, de chacune des première (14, 42) et seconde (16, 44) terminaisons électriques, et s'étendant sur la face latérale, les prolongements (22, 24, 26, 28, 46, 48, 50, 52) ayant une épaisseur suffisante pour établir un intervalle entre la face latérale et le substrat (30) lorsque le condensateur (10, 40) est monté en surface sur le substrat; le montage en surface étant effectué par les prolongements (22, 24, 26, 28, 46, 48, 50, 52) et l'intervalle étant suffisant pour faciliter l'élimination de contaminants d'entre la face latérale et le substrat (30) après le montage.

2. Condensateur selon la revendication 1, dans lequel les première (14, 42) et seconde (16, 44) terminaisons électriques appliquées par projection sont limitées, dans une dimension transversale latérale, de manière à se terminer sensiblement en coïncidence avec la face latérale.

3. Condensateur selon la revendication 1 ou 2, dans lequel la matière formant les première et



seconde terminaisons électriques est l'aluminium et la matière formant les prolongements est le cuivre.

4. Condensateur selon l'une quelconque des revendications précédentes, dans lequel le condensateur (10, 40) comprend deux faces latérales définissant un dessus et un dessous, et les prolongements (22, 24, 26, 28, 46, 48, 50, 52) sont situés sur les deux faces latérales formant le dessus et le dessous.

5. Condensateur selon l'une quelconque des revendications précédentes, dans lequel la structure capacitive (12) comprend plusieurs plaques parallèles; quatre côtés latéraux définissant un dessus, un dessous, un premier côté, un second côté; une première extrémité et une seconde extrémité, la première terminaison électrique (14) étant formée sur la première extrémité et la seconde terminaison électrique (16) étant formée sur la seconde extrémité.

