# United States Patent

**Ozawa et al.**

[15] **3,701,056**

[45] **Oct. 24, 1972**


[54] **RESISTIVE FILM BLEEDER RESISTOR FOR USE IN AN BRANCH CIRCUIT**


[72] Inventors: **Syuichi Ozawa; Noboru Tomimura,** both of Tokyo, Japan

[73] Assignee: **Iwasaki Tsushinki Kabushiki Kaisha (a/k/a Iwatsu Electric Co., Ltd.),** Tokyo-to, Japan



[22] Filed: **Aug. 24, 1970**

[21] Appl. No.: **66,292**

[30] **Foreign Application Priority Data**

Aug. 25, 1969 Japan .....44/66626

[52] **U.S. Cl.**.....**333/8,** 333/81 R, 333/81 A, 338/325

[51] **Int. Cl.**.....**H01p 1/22,** H01c 7/00

[58] **Field of Search**.....333/6, 8, 22, 81, 81 A, 9; 338/308, 309, 325



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,534,302 | 10/1970 | Lee | 333/81 |
| 3,521,201 | 7/1970 | Veteran | 333/81 A |



*Primary Examiner*—Paul L. Gensler

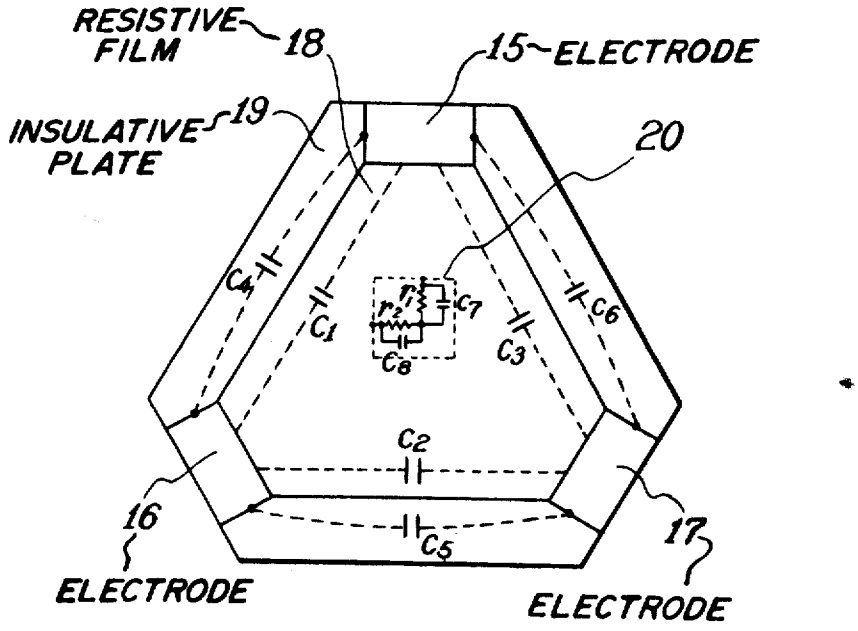
*Attorney*—Robert F. Burns and Emmanuel J. Lobato



[57] **ABSTRACT**

A bleeder resistor used in a branch circuit for dividing a high frequency electric power into a plurality of parts, in which three electrodes are disposed at vertex corners of a regular triangle on an insulative plate, and in which a resistive film is deposited on the surface of the insulative plate so as to be connected to all the three electrodes so that a resistance between any two of the three electrodes is substantially equal to a desired value in a wide frequency range.


**5 Claims, 13 Drawing Figures**



PRIOR ART

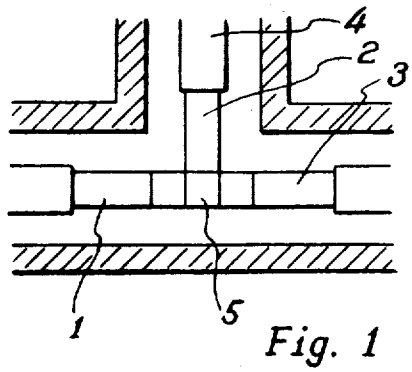



Fig. 1

PRIOR ART

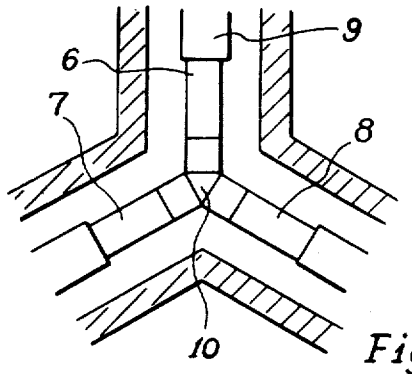



Fig. 2

PRIOR ART

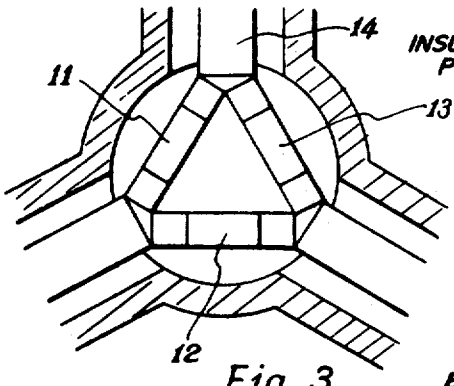



Fig. 3

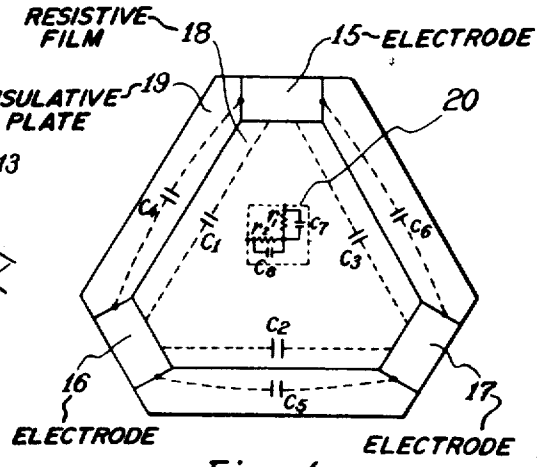



Fig. 4

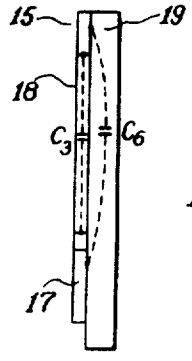



Fig. 5

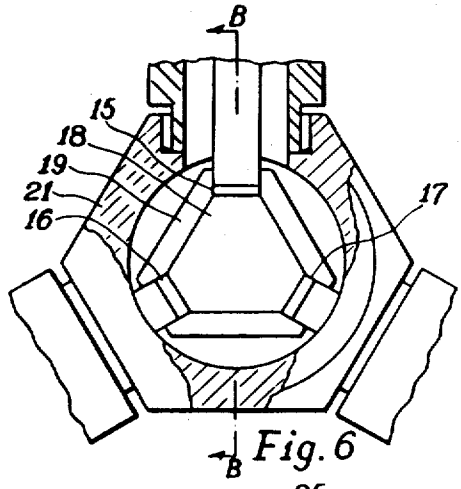



Fig. 6

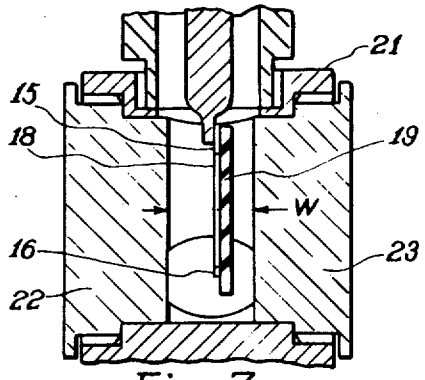



Fig. 7

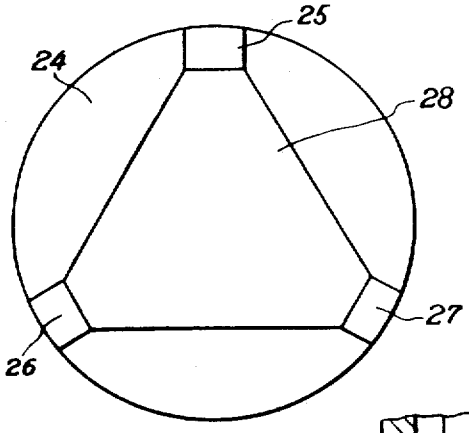



Fig. 8

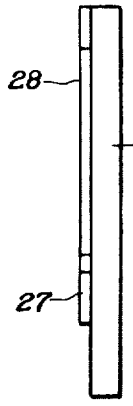



Fig. 9

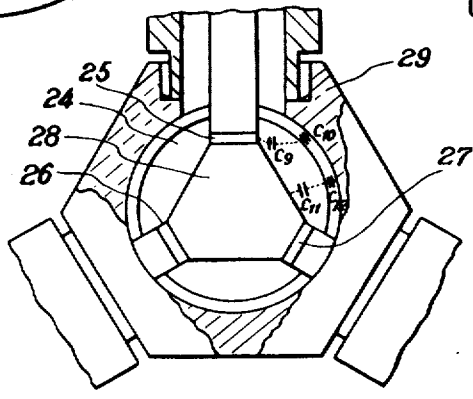



Fig. 10

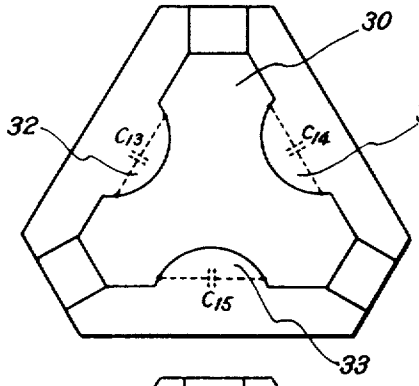



Fig. 11

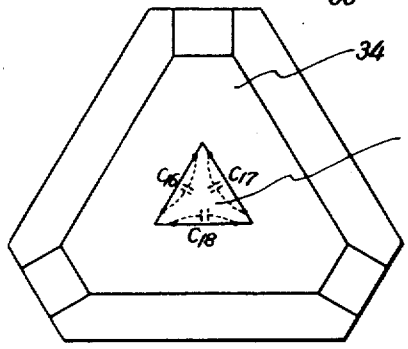



Fig. 12

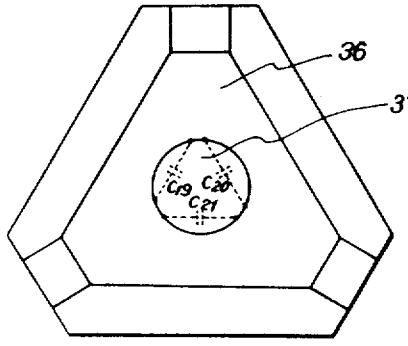



Fig. 13

# RESISTIVE FILM BLEEDER RESISTOR FOR USE IN AN BRANCH CIRCUIT

This invention relates to a bleeder resistor used in a branch circuit for dividing a high frequency electric power into a plurality of parts.

The bleeder resistor of this type has an input terminal matching with an input impedance and a plurality of output terminals so that an input power applied to the input terminal is divided into a plurality of parts, which are derived from the output terminals respectively. However, conventional bleeder resistors have such disadvantages as small allowable input power, structural mis-matching of impedance, and difficulty of miniaturization.

An object of this invention is to provide a bleeder resistor capable of readily performing impedance matching, and capable of being formed into a small size but having a relatively large allowable input power.

In a bleeder resistor of this invention used in a branch circuit for dividing a high frequency electric power into a plurality of parts, three electrodes are disposed, in accordance with the principle of this invention, at vertex corners of a regular triangle on an insulative plate. A resistive film is deposited on the surface of the insulative plate so as to be connected to all of the three electrodes so that a resistance between any two of the three electrodes is substantially equal to a desired value in a wide frequency range. The insulative plate may be a triangular plate whose vertex corners are truncated so as to form a hexagon. The resistive film may have a pattern similar to the pattern of the insulative plate. If necessary, at least a part of the resistive film may be removed to adjust the resistance between any two of the three electrodes.

The invention will be better understood from the following more detailed discussion taken in conjunction with the accompanying drawings, in which:

FIGS. **1**, **2** and **3** are schematic sections illustrating the arrangement of conventional high-frequency branch circuits using bleeder resistors;

FIG. **4** is a plan view illustrating an embodiment of the bleeder resistor of this invention;

FIG. **5** is a right-side view of the embodiment shown in FIG. **4**;

FIG. **6** is a plan view partially in section illustrating the main part of a high-frequency branch circuit using the embodiment shown in FIG. **4**;

FIG. **7** is a section along a line B—B shown in FIG. **6**;

FIG. **8** is a plan view illustrating another embodiment of this invention;

FIG. **9** is a right-side view of the embodiment shown in FIG. **8**;

FIG. **10** is a plan view partially in section illustrating the main part of a high-frequency branch circuit using the embodiment shown in FIG. **8**; and

FIGS. **11**, **12** and **13** are plan views each illustrating another embodiment of this invention.

To make differences between this invention and conventional art clear, examples of conventional high-frequency branch circuits will first be described with reference to FIGS. **1**, **2** and **3**. In an example shown in FIG. **1**, cylindrical rod resistors **1**, **2** and **3** are arranged in a "T-type." On the other hand, cylindrical rod resistors **6**, **7** and **8** are arranged in a "Y-type" in an example shown in FIG. **2**, while cylindrical rod resistors



**11**, **12** and **13** are arranged in a "Δ-type" in an example shown in FIG. **3**. In the examples shown in FIGS. **1** and **2**, if an input signal is applied to an input terminal **4** or **9**, a power larger than power applied across the resistors (**1** and **3**) or (**7** and **8**) is applied to a resistor **2** or **6** connected to the input terminal **4** or **9**. Accordingly, the allowable input power of this high-frequency branch circuit is limited by a relatively small allowable power of the rod resistor **2** or **6**. Moreover, mismatching of impedance is structurally caused at a junction **5** or **10**. In the example shown in FIG. **3**, if an input signal of the same power as the input signal applied to the terminal **4** or **9** is applied to an input terminal **14**, the power of this input signal is divided into two parts by the resistors **11** and **13**. Accordingly, the allowable power of this branch circuit is larger than the example shown in FIG. **1** and **2** since a power smaller than the power applied to the resistor **2** or **4** is applied to the resistors **11** and **13**. However, since electric fields generated by the two divided currents flowing respectively through the resistors **11** and **13** interfere with each other, impedance matching within all the active frequency range is very difficult due to complicated modes of the electric fields. Moreover, miniturization of the above mentioned examples shown in FIGS. **1**, **2** and **3** is difficult.

With reference to FIGS. **4** and **5** an embodiment of this invention comprises three electrodes **15**, **16** and **17** disposed at vertex corners of a regular triangle on an insulative plate **19**, and a triangular, resistive film **18** is deposited on at least one surface of the insulative plate **19** so as to be connected to the electrodes **15**, **16** and **17** at the vertex corners of the triangular resistive film **18** whose vertex corners are cut off perpendicularly to lines bisecting the angles of the triangle so as to form a hexagon having alternate long and short sides. Each of the electrodes **15**,**16** and **17** matches respectively one of the short sides of the hexagon. In this case, this resistive film **18** is deposited on the insulative plate **19** so that the resistance of a unit area (i.e.; area resistance) is constant at any place of the film **18**. In this construction, capacitances $C_1$, $C_2$ and $C_3$ provided by dielectric of the resistive film **18** exist among the three electrodes **15**, **16** and **17**, while capacitances $C_4$, $C_5$ and $C_6$ provided by dielectric of the insulative plate **19** exist also among the three electrodes **15**, **16** and **17**. These capacitances $C_1$, $C_2$, $C_3$, $C_4$, $C_5$ and $C_6$ are equivalently parallel with the resistive film **18**. In other words, the capacitances $C_1$ and $C_4$ exist between the electrodes **15** and **16**, the capacitances $C_2$ and $C_5$ exist between the electrodes **16** and **17**, and the capacitances $C_3$ and $C_6$ exist between the electrodes **17** and **15**. The equivalent circuit **20** of the unit area is shown in FIG. **4**. In this case, since the area resistance is constant at any place of the resistive film **18**, resistances $r_1$ and $r_2$ are equal to each other. Moreover, a first resultant value of the resistance $r_1$ and a capacitance $C_7$ is equal to a second resultant value of the resistance $r_2$ and a capacitance $C_8$. Accordingly, a division ratio $r_1/r_2$ relating to the resistances $r_1$ and $r_2$ is equal to a division ratio $C_7/C_8$ relating to the capacitances $C_7$ and $C_8$. These division ratios have no connection with the frequency of the input signal. This principle can be expanded to the whole area of the resistive film **18**. Moreover, since the three electrodes **15**, **16** and **17** are disposed at the vertex cor-

ners of a regular triangular, the capacitances $C_1$, $C_2$ and $C_3$ are equal to one another while the capacitances $C_4$, $C_5$ and $C_6$ are equal to one another. Accordingly, a desired division ratio can be always obtained.

The bleeder resistor shown in FIGS. **4** and **5** is employed to form a branch circuit as shown in FIGS. **6** and **7**. Impedance-matching can be readily performed by adjusting the space W between two screwed covers **22** and **23** which are screwed into openings in an outer conductor **21**.

To fabricate the bleeder resistor of this invention at a low cost, electrodes **25**, **26** and **27** and a resistive film **28** may be provided on an orbicular plate **24** as shown in FIGS. **8** and **9**. In this case, capacitances $C_9$, $C_{10}$, $C_{11}$ and $C_{12}$ provided by dielectric of an insulative material (e.g.; alumina) and the air gap exist, as shown in FIG. **10**, between the electrodes **25** and an outer conductor **29** and between the resistive film **28** and the outer conductor **29**, so that the attenuation factor of this bleeder resistor increases while mismatching of impedance will not be negligible. In view of the situation, edges of the insulative plate **19** of the embodiment shown in FIG. **4** are cut along the triangular, resistive film **18** so as to form a hexagon similar to the hexagon of the film **18**, so that capacitances between outer conductor **21** and a block of the resistive film **18** and the electrodes **15**, **16** and **17** are reduced. However, if the bleeder resistor is employed to form a branch circuit operating in a low frequency range, the embodiment shown in FIGS. **8**, **9** and **10** is suitable for this purpose.

In order to make resistances between electrodes **15** and **16**, between electrodes **16** and **17**, and between electrodes **17** and **15** equal to one another and to make the area resistance uniform over the whole area of the resistive film **18** in the embodiment shown in FIG. **4**, the resistance of the resistive film **18** is regulated by depositing the resistive film **18** at a uniform thickness and by precise design of respective distances between adjacent electrodes (**15** and **16**), (**16** and **17**) and (**17** and **15**). To meet with these requirements, long adjusting time, highly precise installations and skilful techniques are necessary. However, if a part **35** or **37** or parts **31**, **32** and **33** of a resistive film **34**, **36** or **30** is or are removed as shown in FIGS. **11**, **12** and **13**, the above-mentioned requirements can be readily satisfied. In this case, if respective differences among capacitances $C_{13}$, $C_{14}$ and $C_{15}$, among $C_{16}$, $C_{17}$ and $C_{18}$ and among $C_{19}$, $C_{20}$ and $C_{21}$ are small, the division factor of each of the embodiments shown in FIGS. **11**, **12** and **13** is constant to the extent of a limited frequency since effect of the differences is small with the limited frequency.

What we claim is:

**1**. A bleeder resistor, comprising: an insulative plate,

three like electrodes symmetrically disposed at vertex corners of a regular triangle on the insulative plate and having equal edges each perpendicular to a corresponding one of lines bisecting the respective angles of the regular triangle,

at least one regular triangular resistive film deposited on the surface of the insulative plate and having truncated vertex corners respectively matched with said edges of the three electrodes, so that the resistance between any two of the three electrodes is substantially equal and corresponds to a desired value in a wide frequency range.

**2**. A bleeder resistor according to claim **1**, in which the insulative plate is an orbicular insulative plate.

**3**. A bleeder resistor according to claim **1**, in which said electrodes are rectangular with longer central axes perpendicular respectively to said lines bisecting the angles of said triangle.

**4**. A bleeder resistor according to claim **1**, in which the insulative plate is a triangular plate similar to said regular triangular resistive film and having sides parallel to sides of said triangular resistive film and truncated vertex corners.

**5**. A bleeder resistor according to claim **4**, in which at least a part of the resistive film is removed to adjust the resistance between any two of the three electrodes.

* * * * *