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ELECTRICAL COMPONENT INCLUDING INTRINSICALLY EQUALIZED RESISTANCES

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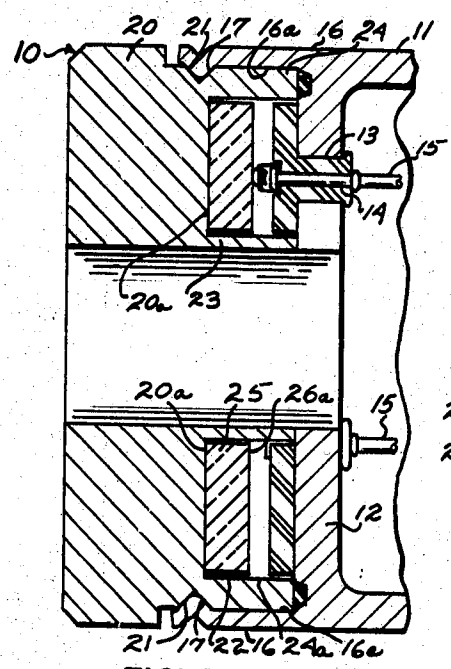



FIGURE-1

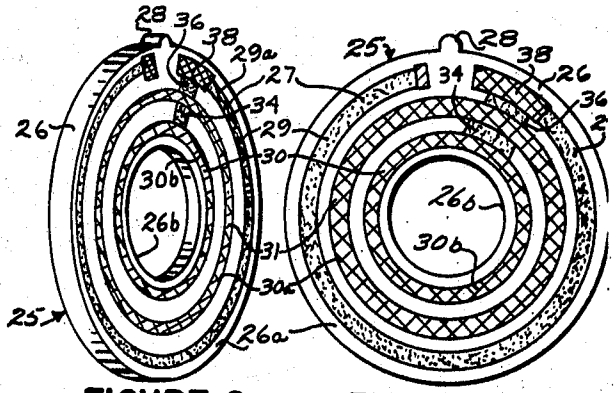



FIGURE-2




FIGURE-3

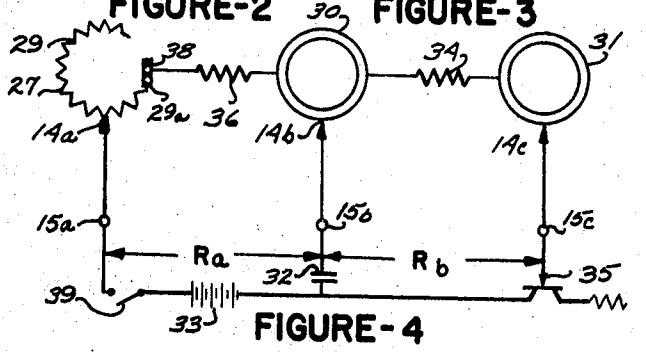



FIGURE-4

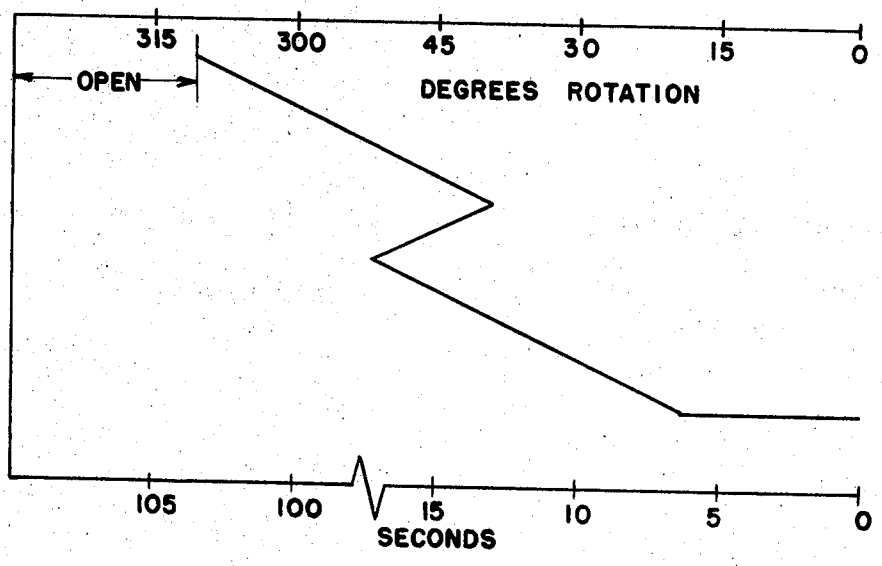



FIGURE-5

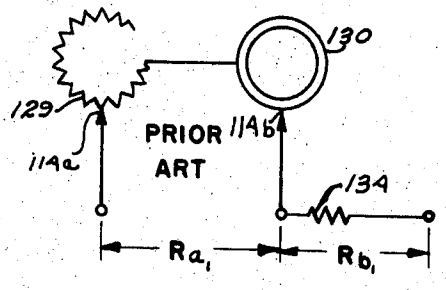



FIGURE-6

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3,564,476

# ELECTRICAL COMPONENT INCLUDING INTRINSICALLY EQUALIZED RESISTANCES

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## ABSTRACT OF THE DISCLOSURE

An electrical component including a circuit module comprising a pair of fixed resistors, a resistance path for a variable resistance control, and a pair of collectors in spaced relationship to the resistance path disposed on a single substrate. One of the fixed resistors is electrically connected between one end of the resistance path and one of the collectors and the other fixed resistor is electrically connected between the two collectors. Contactor means wipably engage the resistance path. Since the pair of fixed resistors and the resistance path are simultaneously formed on the same substrate they have the same relative electrical characteristics and, therefore, are intrinsically equalized.

The present invention relates to an electrical component and, more particularly, to an electrical component including a circuit module having a pair of collectors, a fixed resistor electrically connected between the collectors, and a resistance path having one end electrically connected to the collectors and disposed on a single substrate.

Many timing devices employ an R-C timing circuit having a variable resistance control for altering the timing period. Any change in the resistance setting of the variable resistance control alters the charging rate of a capacitor in the timing circuit and accordingly changes the timing period. In such timing devices, a ratio obtained between the resistance of the variable resistance control and a discrete fixed resistor in the circuit is proportional to the duration of the timing period. In the prior art, even though the variable resistance control is electrically connected to the discrete fixed resistor with relatively movable contactor means to assure that the two resistors are electrically interconnected during rotation of the variable resistance control, instrumental selection of the resistors is necessary to maintain the ratio controlling the timing period within prescribed limits when a change in ambient temperature, humidity or aging of the timing device occurs. Instrumental selection of electrical resistors means the grouping or combining of two or more resistors having similar electrical characteristics and falling within prescribed values and tolerances. It would, therefore, be desirable to provide an electrical timing circuit for a timing device where a collector, a resistance path and the fixed resistor are simultaneously formed on the same substrate and, therefore, intrinsically equalized to assure that any change in environmental conditions, e.g., ambient temperature and aging, will have the same relative effect on the electrical characteristics of both of the resistances.

Accordingly it is an object of the present invention to provide an electrical component with a circuit module having a resistance path for a variable resistance control, a fixed resistor intrinsically equalized to the resistance path, and a pair of spaced collectors supported on a single substrate. Another object of the present invention is to provide an electrical component containing a circuit module having an arcuate resistance path for a variable resistance control, a shorted section connected to one end of the resistance path, a pair of spaced concentric collectors, a first fixed resistor connected between the collectors, and a second fixed resistor connected between



the shorted section and one of the collectors all supported on a single substrate. An additional object of the present invention is to provide an electrical component for an R-C timing circuit where envoronmental changes have the same relative effect upon a resistance path and a fixed resistor employed for determining the duration of the timing period. Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty characterizing the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly, the present invention relates to a circuit module for an electrical timing device employing a timing circuit where the ratio between the resistance path of a variable resistance control and a fixed resistor on the circuit module determines the setting or timing period of the timing device. The resistance path and the fixed resistor are intrinsically equalized by being simultaneously formed on a single substrate to assure that any environmental change, e.g., ambient temperature, humidity and aging, has the same relative effect on the electrical characteristics of the resistances. A pair of collectors are also disposed on the substrate in spaced relationship to the resistance path. One fixed resistor on the substrate is electrically connected between the two collectors and, in a preferred embodiment, a second fixed resistor on the substrate is electrically connected between one of the collectors and a shorted section electrically connected to one end of the resistance path. Contactor means engaging the resistance path and the collectors electrically connect the resistances into the timing circuit.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein the same reference numerals have been applied to like parts and wherein: FIG. 1 is a fragmentary sectional view of an electrical component or timing device employing the circuit module of the present invention; FIG. 2 is an isometric view of the circuit module containing certain passive elements employed in the timing device shown in FIG. 1; FIG. 3 is a top plan view of the circuit module shown in FIG. 2; FIG. 4 is a diagrammatic circuit network of an R-C timing circuit including the elements shown in FIG. 3; FIG. 5 is a graph showing the relationship between angular rotation in degrees and duration in seconds of the timing device; and FIG. 6 is a prior art diagrammatic circuit network.

Referring now particularly to FIG. 1 there is illustrated a fragmentary section of an electrical component or timing device generally designated at **10** having a stationary housing member **11** of cylindrical configuration and a movable housing member **20** rotatably supported by the stationary housing member **11**. The stationary housing member **11** has a partition or supporting wall **12** provided with a plurality of openings **13** passing through the partition. Mounted in each of the openings **13** is a contactor assembly or means **14** having a terminal **15** extending rearwardly of the partition **12** for connecting each of the contactor assemblies **14** into an electrical timing circuit.

For the purpose of axially interlocking the movable housing member **20** with the stationary housing member **11**, the stationary housing member **11** is provided with a forwardly extending cylindrical flange **16** having an inwardly extending peripheral detent **17** receivable in a circumferential groove **21** formed in the movable housing member. The movable housing member **20** is provided with an annular cavity **22** defined by an inner rim or hub **23**, an outer rim **24**, and a bottom wall **20***a*. The outer rim **24** is rotatably supported by the inner wall **16***a* of the cylindrical flange **16** and the detent **17** received in the

groove **21** maintains the members **10** and **20** assembled together permitting relative rotation therebetween. Both the stationary and moving housing members can be of suitable cast metal or plastic. A circuit module **25** comprising an apertured substrate **26** (see FIG. 2) of disc-like configuration having a circuit network **27** on one of the flat surfaces **26***a* thereof is disposed in the annular cavity **22** flatwise against the bottom wall **20***a*. The hub **23** of the movable housing member projects through an aperture **26***b* in the substrate with the inner wall **24***a* of the outer rim circumposing the substrate. Alignment of the substrate in the annular cavity **22** with respect to the movable housing member is obtained with a locating tab **28** (see FIG. 2) projecting radially outwardly from the periphery of the substrate **26** and receivable in a corresponding not shown notch provided in the inner wall **24***a* of the outer rim **24** of the movable housing member.

The circuit network **27** comprises a resistance path **29** formed in the flat surface **26***a* of the substrate having one end **29***a* connected to a pair of collector rings **30, 31** also formed on the flat surface **26***a* of the substrate. The resistance path of the present embodiment is arcuate and can be made by any one of several well known methods. When the substrate is of ceramic material, the resistance path **29** can be defined by a carbon or cermet resistance element deposited and baked or fired to bond the element to the substrate. When a plastic substrate is employed, the resistance path can be defined by a resistance element obtained by embedding conductive particles such as carbon into the plastic such as shown in Tellkamp Pat. No. 2,514,682 which issued on July 11, 1950. Other methods well known in the art for obtaining resistance elements can also be employed for producing the resistance paths of the present invention. Likewise the collectors **30, 31** and method of making the same are well known in the art, e.g., a conductive material such as a silver or platinum-gold paste can be applied onto the surface of the substrate by screening or painting and air dried or fired to produce the collectors **30, 31.** The arcuate resistance path **29** is electrically connected to terminals **15***a*, **15***b* by having one of the buttons or contactor means **14***a* wipingly engage the resistance path **29** and another contactor means **14***b* wipingly engage the collector **30.**

As best shown in FIG. 4 of the drawings, the circuit network **27** forms part of an R-C timing circuit wherein the resistance path **29** is in series with a capacitor **32** and a battery **33.** A fixed resistor **34** and a unijunction transistor **35** are connected in parallel with the capacitor **31.** In the present invention, the arcuate resistance path **29** and the fixed resistor **34** are simultaneously formed on the same substrate and therefore intrinsically equalized to assure that environmental changes will have the same relative effect upon the electrical characteristics of the resistance path **29** and the fixed resistor **34.** As disclosed in pending Barden et al. application Ser. No. 680,190 filed Nov. 2, 1967, a pair of intrinsically equalized resistance elements are employed in variable resistance stereo controls.

The electrical characteristics of the resistance path **29** and the resistor **34** affect the ratio $R_a$ to $R_b$ of the timing device **10.** It is well known that the relationship or ratio of $R_a$ to $R_b$ determines the timing period or duration of the timing circuit, $R_a$ being that portion of the resistance in the circuit between terminals **15***a* and **15***b* while $R_b$ being that portion of the resistance in the circuit between terminals **15***b* and **15***c*. Rotation of the substrate **26** relative to the contactor means **14***a*, **14***b*, i.e., rotation of the movable housing member **20** relative to the stationary housing member **11,** alters the resistance $R_a$ between the terminals **15***a* and **15***b* (see FIG. 4) of the R-C timing circuit, thereby changing the ratio of $R_a$ to $R_b$ and altering the time for building up the voltage of the battery **33** across the capacitor **32** when the battery **33** is connected in series with the capacitor. Accuracy of the timing device **10** is obtained by maintaining the ratio of $R_a$ to $R_b$ constant for a specific setting and this has been a problem in prior art devices.

Prior to the present invention, a circuit network, as shown in FIG. 6 of the drawings, comprised a resistance path **129** and a collector **130** disposed in the same substrate or base. Contactor means **114***a* and **114***b* wipingly engaged the resistance path **129** and the collector **130** for electrically connecting the resistance path **129** into an R-C timing circuit. A discrete, separate, fixed volumetric resistor was connected to the contactor means **114***b* and a relationship of $R_{a1}$ to $R_{b1}$ was obtained. Although extreme care was employed in instrumentally selecting the resistance path **129** to the fixed resistor **134** to assure that changes in environmental conditions and aging would have a minimum effect in changing the resistance value of the resistance path **129** and the fixed resistor **134,** the ratio of $R_{a1}$ to $R_{b1}$ still could not be maintained as accurately as desired.

With the present invention it is now possible to maintain the same ratio more accurately for the same setting regardless of aging and changes in environmental conditions, e.g., humidity and temperature, since the resistance path **29** and the resistor **34** are intrinsically equalized. Intrinsically equalized resistors refer to resistors formed at the same time and on the same substrate thereby utilizing the intrinsic properties of construction. By using the same substrate to support the resistors **29** and **34** and the collectors **30** and **31,** as shown in FIGS. 2 and 3 of the drawings, changes in environmental conditions have a substantially reduced effect upon the resistance ratio of $R_a$ to $R_b$ even if the resistors have different resistivities. In a preferred form of the invention, the resistors **29** and **34** are formed on the same surface **26***a* of the substrate with the same resistance material and therefore also are intrinsically matched, that is, the resistors have the same resistivity and, therefore, have identical electrical characteristics regardless of aging or changes in environmental conditions since the method and resistance material employed in making the resistors are identical and all of the resistors are made at the same time. By being intrinsically matched means that the resistors not only have the same resistivity but also that the resistors have the same or identical properties of construction. Resistors **29** and **34,** therefore, behave the same and are identically affected by aging, and changes in environmental conditions since resistor **29** is exactly similar to resistor **34,** its counterpart, for the same length, width and thickness. The arcuate resistance path **29** formed on the surface **26***a* of the substrate **26** is electrically connected to the collector **30.** The fixed resistor **34** formed on the flat surface **26***a* of the substrate at the same time as the resistance path **29** is interconnected between the collector **30** and the collector **31** located on the surface of the substrate. When a minimum resistance value is desired in the R-C timing circuit in series with the capacitor **32** and the battery, such resistance value is obtained with a fixed resistor **36** also formed at the same time as the fixed resistor **34** and connected between the one end **29***a* of the arcuate resistance path **29** and the collector **30.** The fixed resistor **36** can be eliminated if not shown stop means is employed in the variable resistance control for preventing $R_a$ in the R-C circuit from becoming zero. The fixed resistor **36** is, however, preferred since the control can then be rotated in the same direction for more than 360 degrees.

Of course, when it is desired to maintain the resistance ratio of $R_a$ to $R_b$ constant during initial or intermediate rotation through a certain number of degrees, a shorted section **38** corresponding in degrees to the constant ratio is electrically connected between one end **29***a* of the arcuate resistance path **29** and the collector **30.** The shorted section **38** is made in the same manner as the collectors **30, 31.** A switch **39** is provided in the timing circuit for maintaining the circuit in the off position. The substrate constrained to rotate with the movable housing member **20** can also be rotated relative to the stationary housing

member until the contact means **14***a* extends beyond the end of the arcuate resistance path to open the circuit.

A calibrated dial on the timing device is obtained by providing suitable spaced markings on the periphery of the movable housing member **20** and a zero setting on the periphery of the stationary housing member **11**. A curve such as shown in FIG. 5 of the drawings can be used to correlate degrees rotation to duration of timing period. Before energizing the timing device, the movable housing member is rotated the selected number of degrees to obtain the proper timing period, for example, 45 degrees to obtain a 15 second period. The switch is then closed for energizing the R-C circuit and charging the capacitor **32**. The voltage across the capacitor reaches the predetermined amount, for example 10 volts, in 15 seconds and the unijunction transistor **35** becomes operative to perform a desired function. Although a basic R-C timing circuit is shown in FIG. 4, it is to be understood that the circuit network of the present invention can be employed in various other types of timing circuits for assuring that the ratio $R_a$ to $R_b$ remains constant for a particular setting regardless of aging and/or changes in environmental conditions.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

**1.** In an electrical circuit, the combination of an electrically nonconductive substrate, a resistance path on said substrate, a first collector supported on said substrate in spaced relationship to said resistance path, means electrically connecting the resistance path to the first collector, a second collector supported on said substrate in spaced relationship to the first conductor, and a first resistor on said substrate and electrically connected between the first collector and the second collector, the resistance path and the first resistor being intrinsically equalized.

**2.** The electrical circuit of claim **1**, wherein the resistance path and the first resistor are intrinsically matched.

**3.** The electrical circuit of claim **1**, wherein the resistance path comprises a shorted section.

**4.** The electrical circuit of claim **3**, wherein the shorted section is at one end of the resistance path, and said means comprises a second resistor electrically connecting the shorted section to the first collector.

**5.** The electrical circuit of claim **4**, wherein the substrate is of disc-like configuration, the resistance path is defined by an arcuate resistance element, and the first and second resistors are intrinsically equalized thereby being adherently disposed on said substrate.



**6.** The electrical circuit of claim **5**, wherein the substrate is provided with a centrally located opening, the first and second collectors are adherently deposited on the substrate in concentric relationship to the opening, and the arcuate resistance path circumposes the collectors.

**7.** The electrical circuit of claim **5**, wherein the resistance element and the first and second resistors are intrinsically matched.

**8.** In an electrical component, the combination of a first housing member, a second housing member connected to the first housing member, one of said housing members being movable relative to the other housing, an electrically nonconductive substrate supported by said first housing, a resistance path on said substrate, a first collector supported on said substrate in spaced relationship to the resistance path, first means electrically connecting one end of the resistance path to the first collector, a second collector on said substrate in spaced relationship to the first collector, a first resistor on said substrate and electrically connected between the first collector and the second collector, the resistance path and the first resistor being intrinsically equalized, and wiper means supported by the second housing member wipably engaging the resistance path and the first and second collectors, said wiper means electrically connecting the resistance path and the first resistor into a circuit.

**9.** The electrical component of claim **8**, wherein said first means comprises a shorted section on the substrate electrically connected to the one end of the resistance path, and a second resistor on the substrate electrically connected to the first collector and the shorted section.

**10.** The electrical component of claim **9**, wherein the housing members are rotatable relative to each other, the resistance path is arcuate, and the collectors are in concentric relationship to each other and to the resistance path.

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338—128, 152, 174