United States Patent [19]

Simoni

[11] **3,924,207**

[45] **Dec. 2, 1975**

[54] **VARIABLE ATTENUATOR APPARATUS**

[75] Inventor: **Arnold Simoni**, Don Mills, Canada

[73] Assignee: **Precision Electronics Components Ltd.**, Toronto, Canada

[22] Filed: **Dec. 11, 1974**

[21] Appl. No.: **531,517**

[52] **U.S. Cl.** ..... **333/81 R**; 338/132; 338/174

[51] **Int. Cl.**[2] **H03H 7/26**

[58] **Field of Search** ..... 323/74, 81, 94 R, 96; 333/81 R, 81 A; 338/170

[56] **References Cited**

UNITED STATES PATENTS

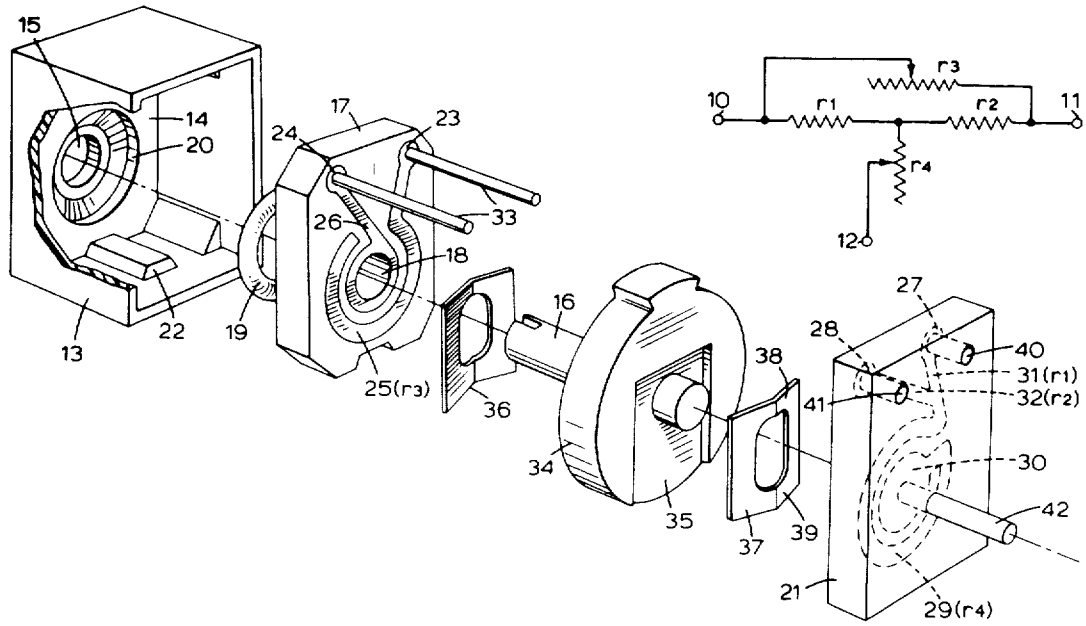
2,884,505	4/1959	Strain et al.	323/74 X
3,341,790	9/1967	Candilis	333/81 R

Primary Examiner—Paul L. Gensler

[57] **ABSTRACT**

The invention provides a variable attenuator apparatus for high frequency application comprising fixed and variable resistance elements moulded together as an integral part on an insulating base supported within an insulating housing, the variable resistance elements being operated in unison from a common rotatable shaft extending inwardly of the housing. A pair of spaced apart stationary insulating substrate elements are supported within the housing, one of the elements including a shaft-receiving aperture through which the rotatable shaft extends, and a contact brush carrier is disposed between the substrate elements and mounted on the rotatable shaft for rotation therewith. Each of the substrate elements has an arcuate resistance track and a conducting collector track, and one substrate element also has a pair of fixed resistors connected between one end of the arcuate resistance track and respective first and second terminals of said element. A pair of spring-loaded contact brushes are mounted on opposite faces of the contact brush carrier, each contact brush being spring biased into sliding bridging engagement with the arcuate resistance track and collector track of the respective substrate element to define a variable resistor. Three external terminal connections to the attenuator network are provided.

6 Claims, 3 Drawing Figures



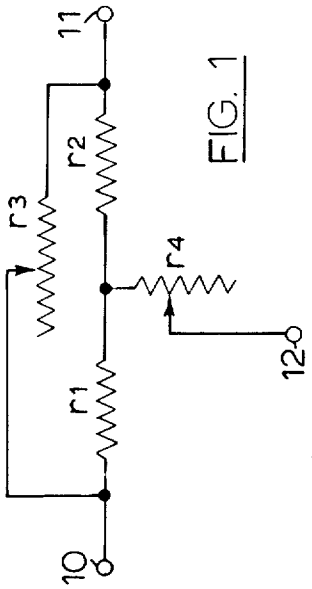


FIG. 1

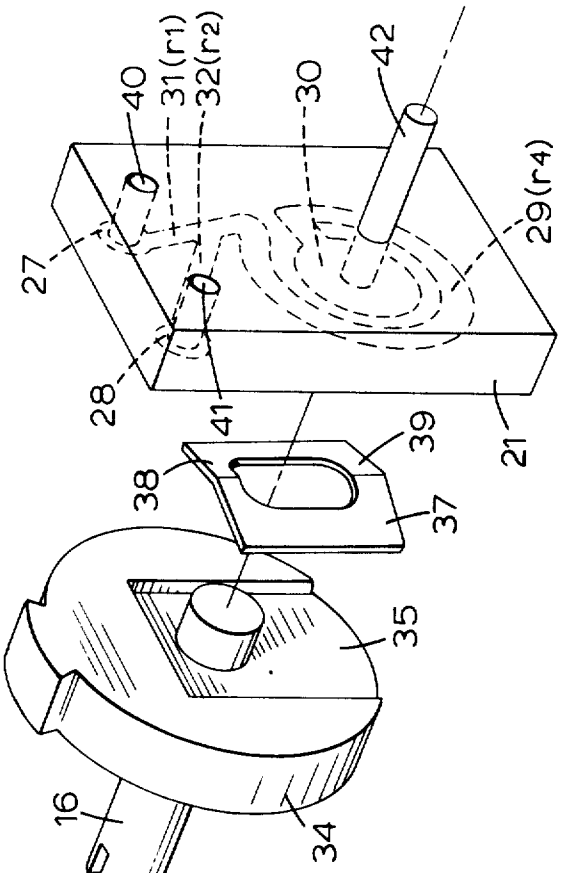
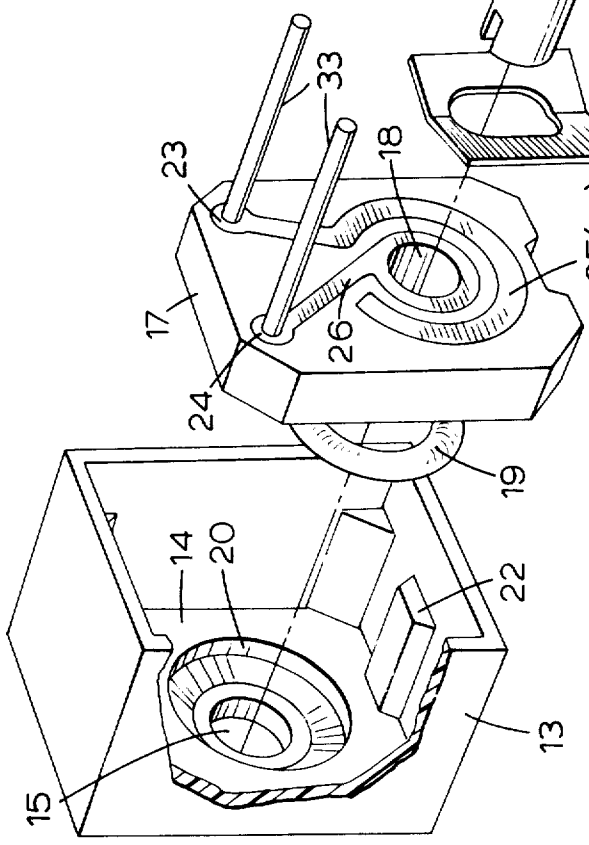


FIG. 2



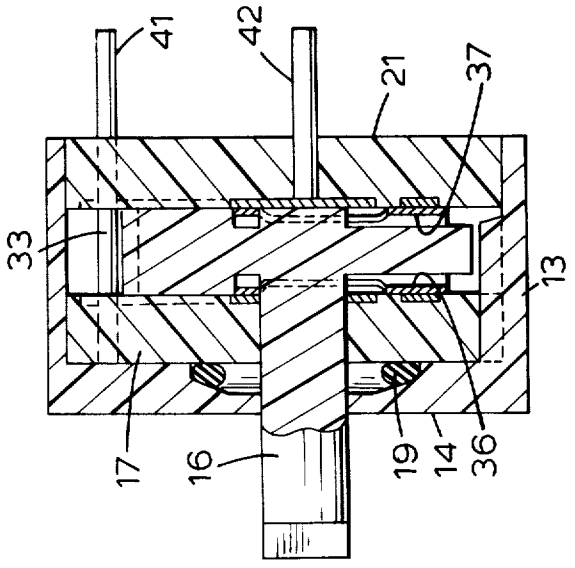


FIG. 3

VARIABLE ATTENUATOR APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to a variable attenuator apparatus, and is concerned primarily with a variable bridged-T attenuator intended for high frequency operation and including both fixed resistors and variable resistors which are operated in unison from a common rotatable shaft.

Variable attenuator apparatus of the type including a pair of variable resistors mounted for dual operation from a common control shaft have been previously proposed. One such apparatus is described in U.S. Pat. No. **3,579,169** issued on May **18, 1971** to Allen-Bradley Company. The apparatus provides a variable resistor assembly for dual operation comprising a pair of arcuate resistance track elements in axially spaced, face-to-face relationship and having interposed therebetween a single insulating rotor or brush carrier including oppositely facing cavities, the brush members being located in the cavities. The brush members are spring-biased into electrical contact with the respective resistance elements, and terminal assemblies are provided for each of the resistance track elements. The apparatus can be adapted for bridged-T or bridged-L operation, external terminals being provided for the connection of fixed resistors according to the type of operation required. The internal construction of the apparatus makes it necessary that the fixed resistors be connected externally to the resistance track elements to complete the attenuating network, thus adding to the overall dimensions of the apparatus and limiting its usefulness for high frequency operation.

The present invention provides a novel construction of bridged-T attenuator wherein the dual operation of the variable resistors does not preclude the internal mounting of fixed resistors, thus avoiding the need for external terminals for their connection and so reducing the overall size of the assembly. The device has just three terminal pins making contact directly with the internal resistors, thereby eliminating the need to make troublesome adjustments as is the case with a device having external terminals to which the fixed resistors are soldered. A bridged-T attenuator apparatus in accordance with the invention, by reason if its internal construction, is particularly well adapted for high frequency operation.

One embodiment of the invention, as applied to a variable bridged-T attenuator apparatus, will now be described by way of example with reference to the accompanying drawings, in which:

FIG. **1** is a schematic wiring diagram of the attenuator network;

FIG. **2** is an exploded perspective view of the apparatus, a part of the housing being broken away to show internal structure; and

FIG. **3** is a vertical section taken along the axis of the apparatus.

Referring to FIG. **1**, the bridged-T attenuator network is of conventional form and comprises a pair of fixed resistors r_1, r_2, of equal resistance value, connected between first and second terminals **10, 11**, a first variable resistance element r_3 being connected between the terminals and in parallel with the fixed resistors. A second variable resistance element r_4, having the same resistance value as r_3, is connected between the junction of resistors r_1 and r_2 and a third terminal **12**. By varying the resistances r_3 and r_4 in unison so that their resistance values are varied in opposite senses, the resistive impedance of the network can be maintained at a specified value for different amounts of attenuation.

Referring now to FIGS. **2** and **3**, the apparatus embodying the bridged-T attenuator network comprises an insulating housing **13**, the housing having a front wall **14** including an aperture **15** through which a rotatable shaft **16** extends inwardly of the housing. A first insulating substrate element **17**, including a shaft-receiving aperture **18** through which the rotatable shaft **16** extends, is supported within the housing adjacent to the front wall **14**, a resilient gasket **19** being located in a recess **20** of the front wall and bearing against the substrate element **17**. A second substrate element **21** is supported within the housing and is spaced from the first element **17** by spacer elements such as **22** which are an integral part of the housing structure. The second substrate element **21**, when so located, constitutes a rear wall of the housing.

The substrate element **17** supports a pair of first and second terminals **23, 24**, an arcuate resistance track **25** (r_3) connected at one end to the first terminal **23**, and a conducting collector track **26** which is connected to the second terminal **24**. The second substrate element **21** supports a corresponding pair of first and second terminals **27, 28**, an arcuate resistance track **29** (r_4), a conducting collector track **30**, and a pair of fixed resistors **31** (r_1) and **32** (r_2). It will be observed that one end of the resistance track **29** is connected to the collector track **30**, and the fixed resistors **31, 32** are connected respectively between the other end of the resistance track **29** and the terminals **27, 28**. The terminals **23, 24** are conductively connected to the terminals **27, 28** respectively, by internal conductors **33**.

A contact brush carrier **34** is mounted on the shaft **16** with which it is integral, and is disposed between the substrate elements **17, 21**. The opposite faces of the carrier **34** are formed with parallel sided recesses of generally rectangular form **35**, and contact brushes **36, 37** constituted by resilient plates are keyed to the opposite faces of the carrier **34** by means of the recesses **35**. Each resilient plate is of generally rectangular shape having an elongated central aperture, the parallel vertical edges of the plate engaging in the respective recess to locate the plate. It will be noted that the plate is bent about a vertical media line so as to provide a pair of outwardly projecting contact regions **38, 39** which respectively engage the collector track and the arcuate resistance track of the respective substrate element.

When the apparatus is assembled, as shown in FIG. **3**, the contact brushes **36, 37** are spring-biased into sliding bridging engagement with the respective arcuate resistance tracks and collector tracks so as to define therewith a pair of variable resistors arranged for dual operation, the variable resistors varying in opposite senses upon rotation of the rotatable shaft **16**. The assembly is therefore compact, all the resistance components of the network being mounted internally of the housing. Only three external terminals are required, for connecting the attenuator in circuit with a network or transmission line, and these are provided by the three terminal pins **40, 41** and **42** which project rearwardly from the rear wall of the housing **13**. The terminal **40**, corresponding to the terminal **10** of FIG. **1**, provides an external connection to resistance elements **31** and **25**

via terminals **27** and **23.** The terminal **41,** corresponding to the terminal **11** of FIG. **1,** provides an external connection to the resistance element **32** and the collector track **26** via the terminals **28** and **24.** The third terminal **42,** corresponding to terminal **12** of FIG. **1,** provides an external connection to the collector track **30** and therefore to the slider of resistance r_4.

The attenuator construction permits great ease of manufacture and assembly, is very compact and therefore especially suitable for high frequency operation, and above all, overcomes the problem of mounting fixed resistors internally in a unit having ganged resistors arranged for dual operation.

What I claim as my invention is:

1. A variable attenuator apparatus comprising:

a housing;

a rotatable shaft extending inwardly of the housing;

first and second spaced-apart, stationary insulating substrate elements supported within the housing, one of said elements including a shaft-receiving aperture through which the rotatable shaft extends, each substrate element supporting a pair of first and second terminals, the first and second terminals of one pair being connected respectively to the first and second terminals of the other pair;

a contact brush carrier disposed between the substrate elements and mounted on the rotatable shaft for rotation therewith;

first and second arcuate resistance tracks and first and second collector tracks supported respectively by the first and second substrate elements;

a pair of fixed resistors supported by the second substrate element and connected respectively between one end of the second arcuate resistance track and the first and second terminals of the second substrate element;

the terminals of the first substrate element being directly connected to one end of the first arcuate resistance track and to the collector track, respectively;

a pair of spring-loaded contact brushes mounted on opposite faces of the contact brush carrier for rotation therewith, each contact brush being spring-biased into sliding bridging engagement with the arcuate resistance track and collector track of the respective substrate element to define therewith a variable resistor, said variable resistors varying in opposite senses upon rotation of the shaft;

a first terminal connection to said interconnected first terminals of the substrate elements;

a second terminal connection to said interconnected second terminals of the substrate elements; and

a third terminal connection to said second collector track.

2. A variable attenuator apparatus according to claim **1,** wherein the pair of fixed resistors are of equal resistance value.

3. A variable attenuator apparatus according to claim **1,** wherein the housing provides a front wall having a shaft-receiving aperture through which the rotatable shaft extends and a rear wall from which the terminal connections extend.

4. A variable attenuator apparatus according to claim **1,** wherein the contact brush carrier is integral with said shaft.

5. A variable attenuator apparatus according to claim **1,** wherein the contact brushes are constituted by resilient plates keyed to opposite faces of the brush carrier.

6. A variable attenuator apparatus according to claim **5,** wherein the opposite faces of the brush carrier are formed with parallel-sided recesses, each resilient plate having a pair of parallel edges engaging in the respective recess and a raised medial portion providing a pair of projecting contact regions respectively engaging the arcuate resistance track and the collector track of a respective substrate element.

* * * * *