July 19, 1966 G. J. NEFF, JR 3,261,929

SUB-MINIATURE SELECTOR DEVICE WITH ECCENTRICALLY DISPLACED CONTACT WIPER APPARATUS

Filed Feb. 17, 1964 2 Sheets-Sheet 1

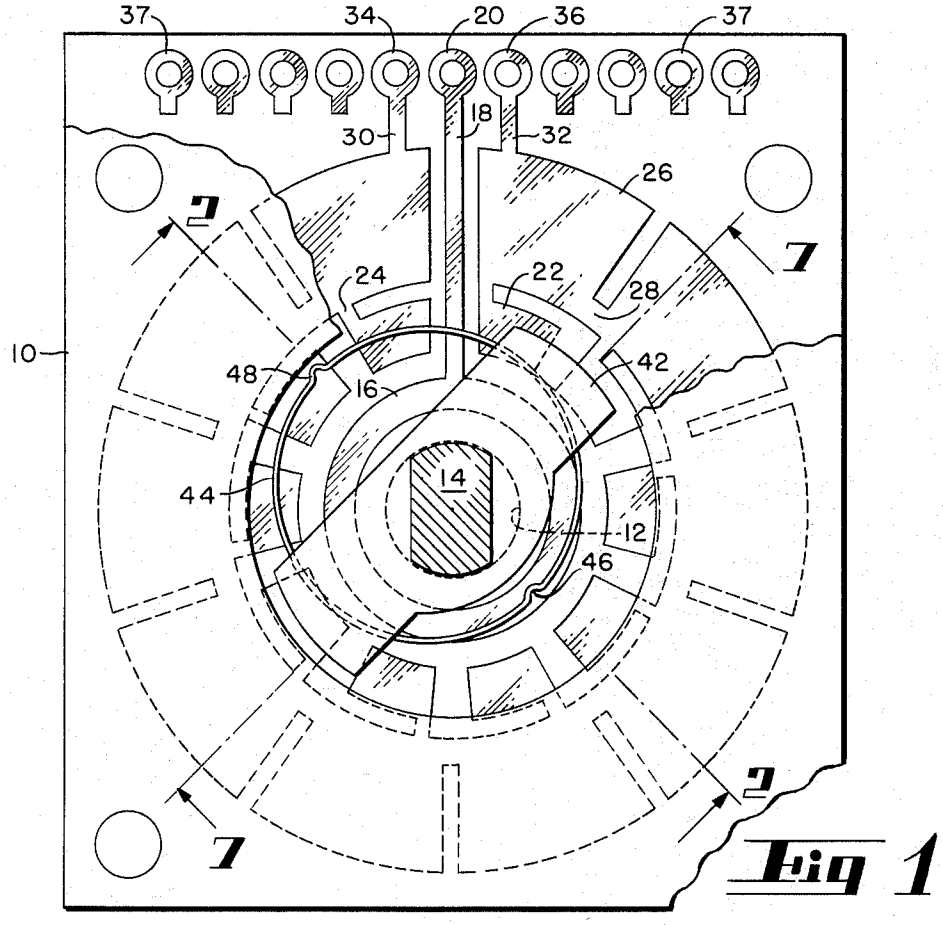


Fig 1

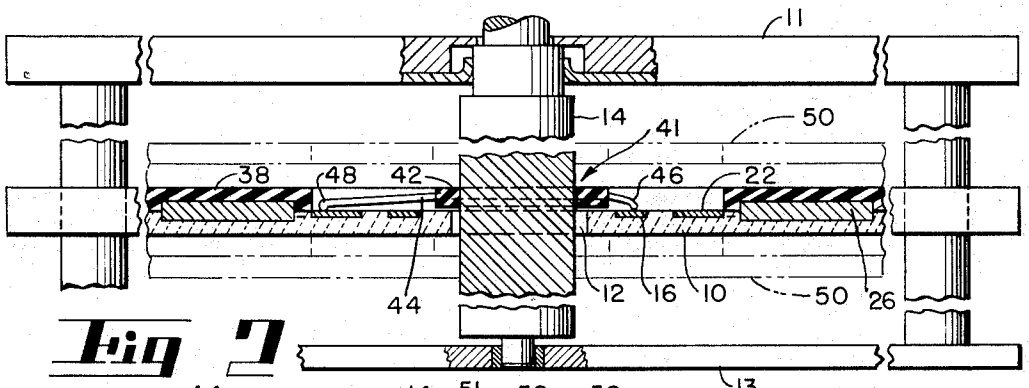


Fig 2

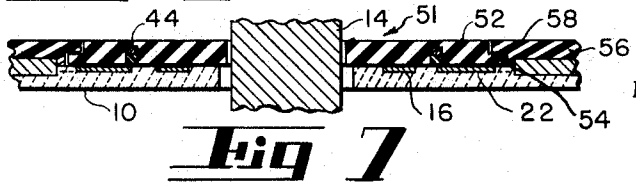


Fig 7

INVENTOR.
GEORGE J. NEFF, JR.
BY Alden D. Redfield
Irwin P. Garfinkle
ATTORNEYS.

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2 Sheets-Sheet 2

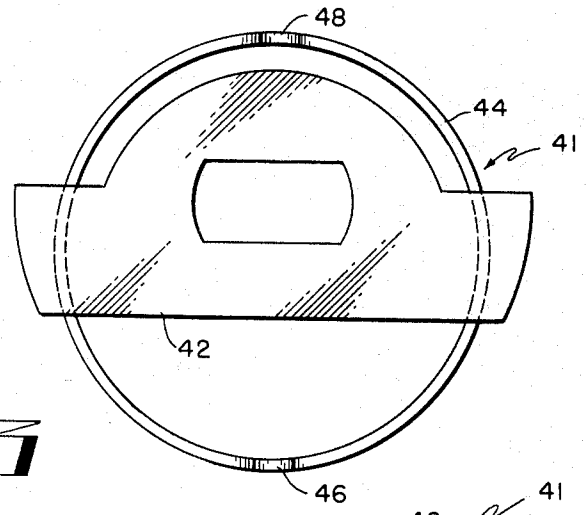


Fig 3

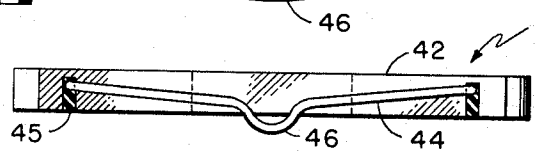


Fig 4

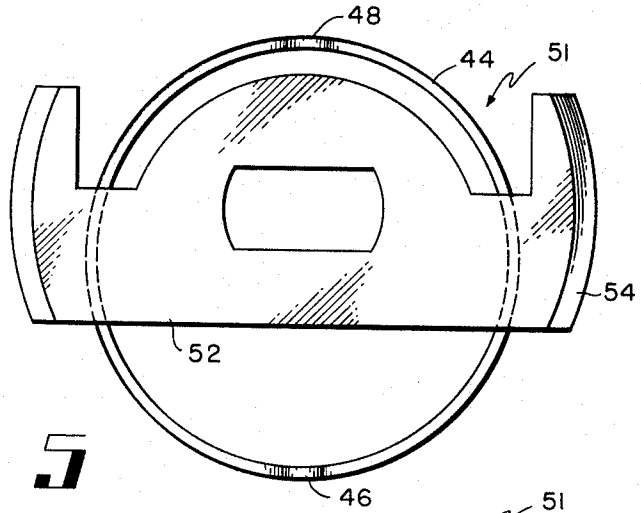


Fig 5

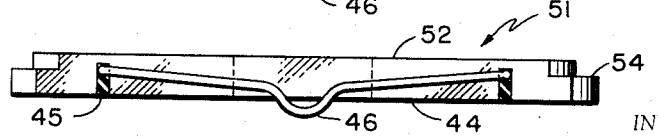


Fig 6

INVENTOR.
GEORGE J. NEFF, JR.
BY Alden D. Redfield
Irwin P. Garfinkle
ATTORNEYS.

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SUB-MINIATURE SELECTOR DEVICE WITH ECCENTRICALLY DISPLACED CONTACT WIPER APPARATUS

George J. Neff, Jr., Erlanger, Ky., assignor to Avco Corporation, Cincinnati, Ohio, a corporation of Delaware

Filed Feb. 17, 1964, Ser. No. 345,259
6 Claims. (Cl. 200—11)

This invention relates to a unique multiposition switch in combination with printed circuit parameters constructed in sub-miniature form.

The present invention provides means for the construction of sub-miniature electric circuit printed parameters and for the selection of particular parameters by the positioning of a unique rotor assembly. Briefly described, circuit parameters are deposited, or otherwise printed, on a ceramic substrate wafer along with a plurality of contacts printed in two concentric arcuate paths surrounding a circular aperture in the wafer. A circular spring contact element, supported on an elongated carrier and eccentrically mounted with respect to the aperture, serves simultaneously to brush the two arcuate paths to select particular output points for connection in other circuitry. The printed circuits may be resistors, capacitors, inductors, or any other parameter adaptable to printed circuit techniques.

It is the primary object of this invention to provide a wafer having circuit parameters printed thereon and on which printed contacts are positioned in concentric arcuate paths around a circular aperture in the wafer, and to provide a rotatable circular spring contact eccentrically positioned with respect to the aperture.

Another object of this invention is to provide a rotatable circular spring member curved along one of its diameters to provide contact points at the ends of said diameter, said circular contact being eccentrically positioned with respect to its axis of rotation for simultaneously contacting two concentric paths of contacts.

Another object of this invention is to provide a unique contact element comprising a circular spring member curved along one of its diameters and carried between the ends of an elongated contact carrier element, said carrier being rotatably mounted, said spring-contact element being eccentrically mounted with respect to the axis of rotation of the carrier.

For further objects and for a better understanding of the invention, reference should be made to the following detailed specification and to the accompanying drawings in which:

FIGURES 1 and 2 illustrate a typical embodiment of this invention;

FIGURES 3 and 4 are views of the contact and carrier of FIGURES 1 and 2;

FIGURES 5 and 6 are views of a modified contact and carrier; and

FIGURE 7 illustrates the assembly for the modified spring contact in captive and self-aligning relationship with respect to the contacts printed on the wafer.

Referring to the drawings, the apparatus includes a ceramic substrate wafer **10** formed with a circular aperture **12** through which extends a shaft **14** rotatably supported coaxially with the aperture **12** in end plates **11** and **13**. The substrate wafer **10**, serving as the stator, is formed with a plurality of trenches and cavities into which various circuit elements are deposited and fired-in, or otherwise printed. These circuit elements include an annular collector ring **16** concentrically positioned around the aperture **12**. A deposited lead **18** connects the ring **16** to a deposited common terminal **20**. Concentrically surrounding the collector ring **16** are a plurality of printed

contacts **22**, each one of which is connected by a short printed lead **24** to a respective one of a plurality of resistance elements **26**. The resistance elements **26** are interconnected by means of short printed leads **28** to provide a series string, the end elements of which are connected by means of printed leads **30** and **32** to terminals **34** and **36**, respectively.

In this embodiment, the remaining terminals **37** are dummies, but are available for other circuit configurations. For example, the leads **24** might be eliminated, and each resistor might be independently connected to a respective one of the terminals.

The various resistor elements **26** are overlaid with a nonconductive spacer **38** affixed to the wafer **10**.

A rotor assembly **41**, including an appropriately apertured contact carrier **42** keyed to the shaft **14**, is positioned within the circular recess formed by the spacer **38** and the wafer **10**. The contact carrier **42** is made of very thin nonconducting material and is provided for supporting a spring contact **44** of generally circular configuration mounted eccentrically with respect to the axis of the shaft **14** in grooves provided at the ends of the contact carrier **42**. The spring contact is maintained in position by an epoxy **45** deposited in the grooves, and is curved or bent downwardly along one of its diameters towards the wafer and provided with dimples **46** and **48** at the points where the spring makes contact with the wafer **10**. Since the spring contact **44** is mounted eccentrically with respect to the rotor shaft, the dimple **46** brushes a circular path of one diameter which includes the contacts **22**, while the dimple **48** brushes the smaller diameter path of the collector ring **16**. Thus, as the shaft **14** is rotated in either direction, the dimple **48** selects a particular contact **22** for connection to the common terminal **20** through the lead **18**, the collector ring **16**, and the spring contact **44**.

While the carrier **42** is angularly fixed with respect to the shaft **14**, the tolerances are such that it is axially movable on the shaft. Thus, when additional units, such as illustrated in dashed lines, are stacked on the shaft **14**, the rotor assembly, including the carrier **42** and the spring contact **44**, is maintained in position, with the spring contact dimples properly aligned and maintained under pressure with the printed collector ring **16** and contacts **22** by the reaction of the spring contact **44** with the bottom of the upper unit **50**.

Because of the very small size of the apparatus, it is necessary that each of the elements be small, and yet it is required that the contact dimples **46** and **48** be maintained under pressure with the wafer contact elements. To accomplish this, the spring contact **44** was made circular in cross section, and two beneficial results were achieved. First, the distance between the grooves on the carrier **42** for supporting the contact were spaced widely apart, thereby reducing the probability of weakening the center of the carrier. Second, the circular configuration permitted the maximum spring pressure for a contact of given radius from the shaft axis.

The modified embodiment of this invention illustrated in FIGURES 5–7 uses an assembly in which the elements of the rotor **51** are self-contained on the wafer. In this embodiment a modified contact carrier **52** is provided at each end with peripheral arcuate flanges **54**, both constituting arcs of the same circle having a center at the axis of shaft **14**. When the contact carrier with its spring contact **44** is positioned on the wafer **10**, it is overlaid with a nonconductive spacer **56** having a complementary circular flange **58** overlying the flange **54** and providing a raceway for it. Thus, the flanged spacer **56** permanently maintains the rotor **51** in position on the wafer **10**. A plurality of such assemblies may be stacked in the same manner as illustrated in FIGURE 2.

The structures of both embodiments of this invention are particularly suited for use in connection with thin film parameters in printed circuits such as illustrated. However, the principles apply broadly to any type of electronic circuitry and to the switching of the circuits and parameters in such circuitry. The illustrated embodiments comprise simple potentiometers in which printed resistor elements are connected in series and a particular output point is selected. Obviously, the device may be used in selecting independent resistors, each connected to a respective one of the terminals **34**, **36** and **37** or each connected to a single one of the terminals. Moreover, it is well within the skill of the art to substitute other printed parameters such as capacitors, inductors, and solid-state devices. Any parameter which may be fabricated in subminiature or thin-film technique may be made the selected element of this miniature device. In practice, a wafer approximately one inch square and aproximately .02 inch thick was used for a 10-element unit such as illustrated. The contact carrier is approximately .04 inch thick. The illustrated embodiments disclose single-pole, multi-position selector elements. However, the invention need not be so limited since each section may be multi-poled and each may be provided with 360-degree rotation or less as the instant problem demands.

It is apparent, therefore, that many modifications and adaptations of this invention will be apparent to persons skilled in the art, and accordingly this invention should be limited only by the appended claims as interpreted in the light of the prior art.

What is claimed is:

1. The combination comprising:

a thin wafer of insulating material having an aperture therethrough;

a shaft rotatable on an axis extending through said aperture;

printed electrical circuitry on one surface of said wafer, said circuitry including first and second annular races of printed contacts, said races being positioned concentrically with the axis of said shaft and having first and second diameters, respectively;

a nonconductive spacer overlying and affixed to said surface of said wafer, said spacer having a circular aperture with a diameter at least as great as the greater of said two races, whereby said races are exposed in a circular recess defined by the circular aperture of said spacer;

an elongated contact carrier positioned within said recess, the ends of said elongated contact carrier comprising the arcs of a circle having a diameter slightly less than the diameter of said recess, said contact carrier being angularly fixed to said shaft but axially movable thereon;

a substantially circular spring contact bridging and fixedly supported from between the ends of said carrier, said spring contact being curved along one of its diameters toward and into contact with said surface, said diameter of said spring contact intersecting the axis of said shaft at a point spaced from the center of the spring contact, the diameter of the spring contact being dimensioned so that one end thereof is at a distance from said axis equal to the radius of one of said races and the other end thereof is at a distance from said axis equal to the other of said races; and

means for axially confining and urging said circular spring contact against said races, said last-named means comprising an inwardly extending flange on said spacer, said flange being spaced from said surface and overlying said carrier for providing an annular raceway for said carrier.

2. The invention as defined in claim **1** wherein said carrier is provided with flanges at said arcs complementary to the flange of said spacer.

3. The invention as defined in claim **2** wherein said printed circuitry comprises conductive contacts.

4. The invention as defined in claim **3** wherein one of said races comprises a continuous circular conductor.

5. The invention as defined in claim **4** wherein the other race comprises a plurality of contacts.

6. The combination comprising:

a thin wafer of insulating material having an aperture therethrough;

a shaft rotatable on an axis extending through said aperture;

printed electrical circuitry on one surface of said wafer, said circuitry including first and second annular races of printed contacts, said races being positioned concentrically with the axis of said shaft and having first and second diameters, respectively;

a nonconductive spacer overlying and affixed to said surface of said wafer, said spacer having a circular aperture with a diameter at least as great as the greater of said two races, whereby said races are exposed in a circular recess defined by the circular aperture of said spacer;

an elongated contact carrier positioned within said recess, the ends of said elongated contact carrier comprising the arcs of a circle having a diameter slightly less than the diameter of said recess, said contact carrier being angularly fixed to said shaft but axially movable thereon;

a substantially circular spring contact bridging and fixedly supported from between the ends of said carrier, said spring contact being curved along one of its diameters toward and into contact with said surface, said diameter of said spring contact intersecting the axis of said shaft at a point spaced from the center of the spring contact, the diameter of the spring contact being dimensioned so that one end thereof is at a distance from said axis equal to the radius of one of said races and the other end thereof is at a distance from said axis equal to the other of said races; and

means for axially confining and urging said circular spring contact against said races.

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ROBERT K. SCHAEFER, *Primary Examiner.*

KATHLEEN H. CLAFFY, ROBERT S. MACON, *Examiners.*

J. R. SCOTT, *Assistant Examiner.*