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(54) **POWER DIVIDER/COMBINER CIRCUIT.**

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to microwave and millimeter wave integrated circuits and more particularly to a planar power divider/combiner circuit which may be used to divide an RF signal into a plurality of signals or combine a plurality of RF signal sources into a single signal.

As used throughout this specification and the claims, the term RF signal includes both microwave and millimeter wave signals.

2. Description of the Related Art

Power divider circuits have been developed to divide RF signals into a number of signals to feed multi-element antennas. Conversely, power combiner circuits were developed to combine the output of a number of solid state amplifiers, chip transitors or oscillators. Several different circuit geometries have evolved to accomplish this power dividing or combining such as: The circular-geometry Wilkinson power divider disclosed in G. J. Wilkinson, "An-N Way Hybrid Power Divider," IRE Trans. on Microwave Theory and Tech., MTT-8 No.1, 116-19 (Jan 1960); the fork power divider disclosed in an article by A. Saleh entitled "Planar, Electrically Symetric N-Way hybrid Power Dividers/Combiners," IEEE Trans. Microwave Theory Tech., MTT-28, No. 6, 555-63 (June 1980); and the radial power divider disclosed in an article authored by J. Schellenberg & M. Cohn, "A Wideband Radial Power Combiner for FET Amplifiers," 1978 IEEE ISSCC Digest 164165, 273 (February 1978). None of these power divider/combiner circuits, however, can provide phase matching, ultra-wide bandwidth, impedance transforming, port to port isolation in a planar compact power dividing and combining circuit all at the same time.

Therefore, it is an object of the present invention to provide a power divider/combiner circuit for microwave and millimeter signals which simultaneously can provide phase matching, ultra-wide bandwidth, impedance transforming and port to port isolation.

Accordingly, it is therefore an object of the present invention to provide a compact planar integrated circuit for both dividing and combining microwave and millimeter signals.

It is yet another object of the present invention to provide a power divider/combiner circuit that achieves greater than a 100% bandwidth.

It is still a further object of the present invention to provide a power divider/combiner circuit which divides a single signal source into a plurality of equiphase, equi-amplitude signals over a broad frequency range.

It is still a further object of the present invention to provide a power divider/combiner circuit which provides phase matching at each port to ensure efficient power combining.

It is yet another object of the present invention to provide a power divider/combiner circuit that combines a plurality of RF signals sources efficiently into one RF signal of magnitude equal to the sum of all the signal sources.

It is still a further object of the present invention to provide a power divider/combiner circuit that provides impedance transforming and power combining or dividing at the same time.

This is achieved by a power divider/combiner circuit in accordance with claim 1 or 14.

A power divider/combiner circuit according to the invention comprises a flat tapered strip of electrically conductive material with a plurality of slots of constant width extending from the wide end of the tapered strip toward the narrow end of tapered the strip such that the strip defines a plurality of tapered fingers. The narrow end of the tapered strip forms one port, either an input or an output port, and the respective tips of the fingers form a plurality of ports which can be either input ports or output ports. Isolation resistors may connect adjacent fingers at quarter wavelength distances along the fingers. The tapered strip is mounted on a dielectric substrate.

An input signal from an RF signal source may be fed into the single port at the narrow end of the tapered strip, The input signal will be divided into a plurality of RF signals of equi-amplitude and equal phase at the finger ports. Conversely, when a plurality of RF input signals are fed into the finger ports, these signals will combine into a single RF signal at the single port at the narrow end of the tapered strip.

The subclaims are directed to preferred embodiments.

Additional objects, advantages and characteristic features of the invention will become readily apparent from the following detailed description of a preferred embodiment of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a is a top plan view of a power divider/combiner circuit according to the principles of the present invention;

FIG. 1b is a cross-sectional view taken along line 1b-1b of FIG, 1a; and

FIG. 2 is an enlarged perspective view partly broken away, illustrating a portion of a power divider/combiner circuit according to another embodiment of the invention.

FIG. 3 is a top plan view illustrating still another embodiment of the invention using a pair of power divider/combiner circuits. It will be appreciated that FIGS. 1-3 are not drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1a and 1b with greater particularly, a power divider/combiner circuit 10 according to the invention may include a tapered strip of electrically conductive material 1 with a narrow end 2 and a wide end 3. The tapered strip 1 is preferably made of a metal such as gold, but may be made of any other good electrically conductive material. The strip may be about 2-3 skin depths thick for the lower frequency of the desired bandwidth of operation. The tapered strip 1 provides a tapered transmission line in which the contour of the taper is selected to match the impedance at the narrow end 2 of the tapered strip to the impedance at the wide end 3 of the tapered strip over the desired bandwidth of operation. The contour and lengths of the taper determine the maximum inband reflection coefficient and the lower cut off frequency, respectively.

While many taper geometries are available, such as an exponential taper or a hyperbolic taper, a Dolph-Tchebycheff taper has been found to afford optimum performance because it provides a minimum length for the transmission line for a specified maximum magnitude reflection coefficient in the passband. The design equations for the Dolph-Tchebycheff taper may be found in an article authored by R. W. Klopfenstein entitled "A Transmission Line Taper of Improved Design," 44 Proc. IRE 31-35 (Jan. 1956), which is incorporated herein by reference.

The tapered strip 1 has a plurality of slots 4 therein extending from the wide end 3 of the strip toward the narrow end 2 of the strip which define a plurality of conductor fingers 5. The narrow end 2 of the tapered strip 1 thus defines a single port 2 which can be either an input port or an output port depending on whether the circuit is used as a power divider or combiner, respectively. The tips of the conductor fingers 5 at the wide end 2 of the strip 1 define N ports 6, where N is an integer greater than 1, which can be either output ports or input ports depending on whether the circuit is used as a power combiner or divider, respectively. Although 5 ports are shown FIGS 1a and 1b, any number of ports are possible. The slot width, i.e. the spacing between the adjacent fingers 5, should be kept small to enhance coupling between adjacent fingers and thus ensure that the structure retains the characteristics of a DolphTchebycheff tapered transmission line. A slot width of about 38 μm (1.5 mil) has been typically used.

The fingers 5 function as strip line conductors. Several methods are available for determining the appropriate widths (even mode impedance) and gap spacings for strip line conductors, such as disclosed in J. I. Smith, "The Even and Odd Mode Capacitance Parameters for Coupled Lines in Suspended Substrate." IEEE Trans. Microwave Theory Tech., Vol. MTT-19, pp. 424-31 (May 1971) or T, Itoh & A. S. Herbert, "A Generalised Spectrum Domain Analysis for Coupled Suspended Microstriplines with Tuning Septums," IEEE Trans Microwave Theory Tech, Vol, MTT-26, pp, 820-27, (Oct. 1978), which are incorporated herein by reference.

The methods described in the aforementioned publications are designed to determine widths and gap spacing for strip conductors of uniform width. Since the conductor strip fingers 5 of the present invention are tapered, the equations for determining the widths of uniform width strip line conductors disclosed in these publications should be reiteratively applied to determine the width of each finger strip at a sufficient number of points along the strip to define the appropriate taper.

Isolation resistors 7 connect adjacent conductor fingers 5. The resistors 7 absorb signals that are reflected back into the power divider/combiner circuit, the odd mode propagation. These resistors may be chip resistors 7 disposed on top of the strip as illustrated in FIG. 1, or thick or thin film resistors 7′ located between the fingers 5 in the slots 4 on the substrate 8, as illustrated in FIG. 2.

The number of isolation resistors 7 disposed along each pair of adjacent fingers 5 should preferably be one less than the total number of finger ports in the circuit to effectively absorb the propagation of odd modes. Thus in the exemplary embodiment shown in FIGS. 1a and 1b, where 5 ports are used there are 4 resistors along each pair of adjacent fingers. However, additional or fewer resistors also may be employed.

Several methods are available for determining the resistance value for the isolation resistors 7, First the "variational method" or the "spectral domain method" disclosed in the Smith or Itoh 9 Herbert articles referred to above accurately provide the odd mode impedance needed to calculate the resistance of the isolation resistors 7. Then resistance values can be determined using the method disclosed in N. Nagai, E. Matkawa, and K. Ono, "New N-Way Hybrid Power Dividers," IEEE Trans. Microwave Theory Tech., Vol, MTT-25, No. 12, pp. 1008-1012 (Dec. 1977), which is incorporated herein by reference.

The tapered strip 1 may be adhesively mounted onto a dielectric substrate 8 which is generally a thin flat plate of dielectric material. The substrate for example, may be made of sapphire, berryllium oxide, quartz, or alumina. The adhesive material 9 may be chrome or ti-tungsten or any other good conductive adhesive material. In operation, the dielectric substrate may be grounded at the bottom surface 11 of the substrate 8.

FIG. 3 illustrates a power divider/combiner circuit according to a further embodiment of the present invention. The circuit of FIG. 3 includes an RF signal source 30 which may be an oscillator or amplifier, for example. The signal from the source 30 is fed into the single port 2a of a power divider/combiner circuit 31. This single RF signal is divided into a plurality of RF signals at the finger ports 6a. These signals are amplified by respective amplifiers 32, which may be hybrid amplifiers, pre-matched chips, microwave monolithic integrated circuit chips, transitor chips, for example, and fed into respective finger ports 6b of power divider/combiner circuit 33 according to the invention which, in turn, combines these N amplified RF signals into a single RF signal at port 2b. The resultant output signal is the station of the various output signals from the amplifiers 32.

Claims

1. A power divider/combiner circuit, which comprises:

a dielectric substrate (8);

a tapered strip (1) of electrically conductive material mounted on said substrate (8), said strip (1) having a wide end (3), a narrow end (2), and a plurality of slots (4) therein of constant width extending along the length of said tapered strip (1) from the wide end (3) to the narrow end (2) defining a plurality of tapered fingers, the width of said slots (4) being sufficiently small to enhance coupling between adjacent fingers (5);

and resistive means (7; 7′) electrically connecting adjacent ones of said fingers (5).

2. A power divider/combiner circuit as defined in claim 1, characterized in that said strip (1) is tapered from the wide end (3) to the narrow end (2) in a Dolph-Tchebycheff taper.

3. A power divider/combiner circuit as defined in claim 1, characterized in that said strip (1) is tapered from the wide end (3) to the narrow end (2) in a hyperbolic taper.

4. A power divider/combiner circuit as defined in claim 1, characterized in that said strip (1) is tapered from the wide end (3) to the narrow end (2) in an exponential taper.

5. A power divider/combiner circuit as defined in any one of Claims 1, 2, 3, and 4 further comprising means for applying an input signal to the narrow end (2) of said tapered strip (1).

6. A power divider/combiner circuit as defined in any one of Claims 1, 2, 3, and 4 further comprising means for applying a plurality of input signals to said fingers (5) at said wide end (3) of said tapered strip (1).

7. A power divider/combiner circuit as defined in any one of Claims 1, 2, 3, and 4 characterized in that said resistive means comprises a plurality of resistors (7; 7′) electrically connecting adjacent ones of said fingers (5) at quarter wavelength distances along the fingers (5) for signals selectively applied to either said narrow end (2), or the ends of respective fingers (5) at said wide end (3).

8. A power divider/combiner as defined in Claim 7, characterized in that said resistors (7) are chip resistors disposed on top of said strip (1) overlapping adjacent portions of adjacent ones of said fingers (5).

9. A power divider/combiner as defined in Claim 7, characterized in that said resistors are thick film resistors (7′) which are located on said substrate (8) between adjacent ones of said fingers (5) in said slots (4) and which make electrical contact with adjacent portions of adjacent ones of said fingers (5).

10. A power divider/combiner as defined in Claim 7 characterized in that said resistors (7′) are thin film resistors which are located on said substrate (8) between adjacent ones of said fingers (5) in said slots (4) and which make electrical contact with adjacent portions of adjacent ones of said fingers (5).

11. A power divider/combiner as defined in any one of Claims 1, 2, 3, or 4, characterized in that said dielectric substrate (8) is of a material selected from the group consisting of sapphire, berryllium oxide, quartz and alumina.

12. A power divider/combiner circuit as defined in any one of Claims 1, 2, 3, or 4, characterized in that said tapered strip is of metal and is about three skin depths thick for the lower frequency of the desired band of operation.

13. A power divider/combiner circuit as defined in any one of Claims 1, 2, 3, or 4, characterized in that the spacings between adjacent ones of said fingers, i. e. the slot widths, are about 38 μm (1.5 mils).

14. A power divider/combiner circuit which comprises:

a first dielectric substrate;

a first tapered strip of electrically conductive material mounted on said substrate, said strip having a wide end (6a), a narrow end (2a), and a plurality of slots therein of constant width extending along the length of said tapered strip from the wide end to the narrow end defining a plurality of first fingers, the width of said slots being sufficiently small to enhance coupling between adjacent fingers;

first resistive means electrically connecting adjacent ones of said first fingers;

means (30) for applying a first signal to the narrow end (2a) of said first tapered strip;

a second dielectric substrate;

a second tapered strip of electrically conductive material mounted on said second substrate, said second strip having a wide end (6b), a narrow end (2b), and a plurality of slots therein of constant width extending along the length of said second tapered strip from the wide end to the narrow end defining a plurality of second fingers the width of said slots being sufficiently small to enhance coupling between adjacent fingers;

second resistive means electrically connecting adjacent ones of said second fingers; and

signal translating means (32) electrically connected between respective corresponding pairs of said first and second fingers.

15. A power divider/combiner circuit as defined in claim 14 wherein said translating means comprises a plurality of amplifiers (32).

Revendications

1. Circuit diviseur/combinateur de puissance comportant :

un substrat diélectrique (8) ;

une bande de largeur décroissante (1) en matériau électriquement conducteur, formée sur ledit substrat (8), laquelle bande (1) possède une extrémité large (3), une extrémité étroite (2) et plusieurs fentes (4) de largeur constante qui s'étendent suivant la largeur de ladite bande de largeur décroissante (1) depuis l'extrémité large (3) jusqu'à l'extrémité étroite (2), définissant plusieurs doigts de largeur décroissante, la largeur desdites fentes (4) tant suffisamment faible pour accroître le couplage entre doigts adjacents (5) ; et

des moyens résistifs (7, 7′) reliant électriquement des doigts (5) adjacents.

2. Circuit diviseur/combinateur de puisance conforme à la revendication 1, caractérisé en ce que la largeur de ladite bande (1) décroît depuis l'extrémité large (3) jusqu'à l'extrémité étroite (2) suivant un profil de Dolph-Tchebycheff.

3. Circuit diviseur/combinateur de puissance conforme à la revendication 1, caractérisé en ce que la largeur de ladite bande (1) décroît depuis l'extrémité large (3) jusqu'à l'extrémité étroite (2) suivant un profil hyperbolique.

4. Circuit diviseur/combinateur de puissance conforme à la revendication 1, caractérisé en ce que la largeur de ladite bande (1) décroît depuis l'extrémité large (3) jusqu'à l'extrémité étroite (2) suivant un profil exponentiel.

5. Circuit diviseur/combinateur de puissance conforme à l'une des revendications 1 à 4, comportant en outre des moyens pour appliquer un signal d'entrée à l'extrémité étroite (2) de ladite bande de largeur décroissante (1).

6. Circuit diviseur/combinateur de puissance, conforme à l'une des revendications 1 à 4, comportant en outre des moyens pour appliquer plusieurs signaux d'entrée audits doigts (5) à l'extrémité large (3) de ladite bande de largeur décroissante (1).

7. Circuit diviseur/combinateur de puissance conforme à l'une des revendications 1 à 4, caractérisé en ce que les moyens résistifs comprennent plusieurs résistances (7, 7′) reliant électriquement des doigts (5) adjacents, espaces le long des doigts (5) d'un quart de longueur d'onde, pour des signaux appliqués sélectivement soit à ladite extrémité étroite (2), soit aux extrémités de doigts respectifs (5) à ladite extrémité large (3).

8. Diviseur/combinateur de puissance conforme à la revendication 7, caractérisé en ce que lesdites résistances (7) sont des résistances en forme de plaquette disposées sur la partie supérieure de ladite bande (1), chevauchant les parties adjacentes de doigts (5) adjacents.

9. Diviseur/combinateur de puissance conforme à la revendication 7, caractérisé en ce que lesdites résistances sont des résistances en couche épaisse (7′) qui sont situées sur ledit substat (8) entre des doigts (5) adjacents, dans lesdites fentes (4), et qui sont en contact électrique avec les parties adjacentes de doigts (5) adjacents.

10. Diviseur/combinateur de puissance conforme à la revendication 7, caractérisé en ce que lesdites résistances (7′) sont des résistances en couche mince qui sont situées sur ledit substrat (8) entre des doigts (5) adjacents, dans lesdites fentes (4), et qui sont en contact électriques avec les parties adjacentes de doigts (5) adjacents.

11. Diviseur/combinateur de puissance conforme à l'une des revendications 1 à 4, caractérisé en ce que ledit substrat diélectrique (8) est réalisé en un matériau choisi dans le groupe constitué par le saphir, l'oxyde de béryllium, le quartz et l'alumine.

12. Circuit diviseur/combinateur de puissance conforme à l'une des revendications 1 à 4, caractérisé en ce que ladite bande de largeur décroissante est métallique et épaisse d'environ 3 épaisseurs de peau pour la fréquence la plus basse de la bande de fonctionnement désirée.

13. Circuit diviseur/combinateur de puissance conforme à l'une des revendications 1 à 4, caractérisé en ce que les espacements entre doigts adjacents, c'est-à-dire les largeurs des fentes sont d'environ 38 μm (1,5 millième de pouce).

14. Circuit diviseur/combinateur de puissance qui comporte :

un premier substrat diélectrique ;

une première bande de largeur décroissante en matériau électriquement conducteur, formée sur ledit substrat, laquelle bande possède une extrémité large (6a), une extrémité étroite (2a) et plusieurs fentes de largeur constante qui s'étendent suivant la longueur de ladite bande de largeur décroissante depuis l'extrémité large jusqu'à l'extrémité étroite, définissant plusieurs premiers doigts, la largeur desdites fentes étant suffisamment faible pour accroître le couplage entre doigts adjacents ;

des premiers moyens résistifs reliant électriquement des premiers doigts adjacents ;

des moyens (30) pour appliquer un premier signal à l'extrémité étroite (2a) de ladite bande de largeur décroissante ;

un second substrat diélectrique ;

une seconde bande de largeur décroissante en matériau électriquement conducteur, formée sur ledit second substrat, laquelle seconde bande possède une extrémité large (6b), une extrémité étroite (2b) et plusieurs fentes de largeur constante s'étendant suivant la largeur de ladite seconde bande de largeur décroissante depuis l'extrémité large jusqu'à l'extrémité étroite, définissant plusieurs seconds doigts, la largeur desdites fentes étant suffisamment faible pour accroître le couplage entre doigts adjacents;

des seconds moyens résistifs reliant électriquement des seconds doigts adjacents ; et

des moyens (32) de transfert de signal reliés électriquement respectivement à des paires de premiers et seconds doigts correspondants.

15. Circuit diviseur/combinateur de puissance conforme à la revendication 14, dans lequel les moyens de transfert comportent plusieurs amplificateurs (32).

Patentansprüche

1. Ein Leistungsteiler- und Summiererschaltkreis, mit:

einem dielektrischen Substrat (8);

einem sich verjüngenden Streifen (1) aus elektrisch leitendem Material, der auf dem Substrat (8) aufgebracht ist und breites Ende (3), ein schmales Ende (2) und eine Mehrzahl von Schlitzen (4) mit konstanter Breite aufweist, die sich entlang der Länge des sich verjüngenden Streifens von dem breiten Ende (3) zu dem schmalen Ende (2) erstrecken und eine Mehrzahl von sich verjüngenden Fingern definieren, wobei die Breite der Schlitze (4) genügend klein ist, um die kopplung zwischen benachbarten Fingern (5) zu verbessern;

und Widerstandseinrichtungen (7; 7'), die einander benachbarte Finger (5) elektrisch verbinden.

2. Leistungsteiler- und Summiererschaltkreis nach Anspruch 1, dadurch gekennzeichnet, daß der Streifen (1) sich von dem breiten Ende (3) zu dem schmalen Ende (2) gemäß einer Dolph-Tchebycheff-Funktion verjüngt.

3. Leistungsteiler- und Summiererschaltkreis nach Anspruch 1, dadurch gekennzeichnet, daß der Streifen (1) sich von dem breiten Ende (3) zu dem schmalen Ende (2) gemäß einer hyperbolischen Funktion verjüngt.

4. Leistungsteiler- und Summiererschaltkreis nach Anspruch 1, dadurch gekennzeichnet, daß der Streifen (1) sich von dem breiten Ende (3) zu dem schmalen Ende (2) in exponentieller Weise verjüngt.

5. Leistungsteiler- und Summiererschaltkreis nach einem der vorhergehenden Ansprüche, gekennzeichnet durch Einrichtungen zum Einbringen eines Eingangssignals zu dem schmalen Ende (2) des sich verjüngenden Streifens (1).

6. Leistungsteiler- und Summiererschaltkreis nach einem der Ansprüche 1, 2, 3 bzw. 4, gekennzeichnet durch Einrichtungen zum Einbringen einer Mehrzahl von Eingangssignalen zu den Fingern (5) an dem breiten Ende (3) des sich verjüngenden Streifens (1).

7. Leistungsteiler- und Summiererschaltkreis nach einem der Ansprüche 1, 2, 3 bzw. 4, dadurch gekennzeichnet, daß die Widerstandseinrichtungen eine Mehrzahl von Widerständen (7; 7') umfassen, die benachbarte der Finger (5) für Signale, die selektiv entweder dem schmalen Ende (2) oder dem Ende der Finger (5) an dem breiten Ende (3) in Viertelwellenlängen-Abständen entlang der Finger (5) elektrisch miteinander verbinden.

8. Leistungsteiler- und Summiererschaltkreis nach Anspruch 7, dadurch gekennzeichnet, daß die Widerstände (7) Chip-Widerstände sind, die auf der Oberseite des Streifens (1) angebracht sind und einander gegenüberliegende Teile benachbarter Finger (5) überlappen.

9. Leistungsteiler- und Summiererschaltkreis nach Anspruch 7, dadurch gekennzeichnet, daß die Widerstände Dickfilm-Widerstände (7') sind, die auf dem Substrat (8) zwischen benachbarten Fingern (5) in den Schlitzen (4) angeordnet sind und den elektrischen kontakt zwischen einander gegenüberliegenden Teilen der benachbarten Finger (5) herstellen.

10. Leistungsteiler- und Summiererschaltkreis nach Anspruch 7, dadurch gekennzeichnet, daß die Widerstände (7') Dünnfilm-Widerstände sind, die auf dem Substrat zwischen benachbarten Fingern (5) in den Schlitzen (4) angeordnet sind und den elektrischen kontakt zwischen einander gegenüberliegenden Teilen der benachbarten Finger (5) herstellen.

11. Leistungsteiler- und Summiererschaltkreis nach einem der Ansprüche 1, 2, 3 oder 4, dadurch gekennzeichnet, daß das dielektrische Substrat (8) ein Material aus der Gruppe bestehend aus Sapphir, Berrylliumoxid, Quartz und Aluminiumoxid ist.

12. Leistungsteiler- und Summiererschaltkreis nach einem der Ansprüche 1, 2, 3 oder 4, dadurch gekennzeichnet, daß der sich verjüngende Streifen aus Metall ist und ungefähr drei Skin-Dicken für die niedrigere Frequenz des gewünschten Betriebs-Frequenzbandes dick ist.

13. Leistungsteiler- und Summiererschaltkreis nach einem der Ansprüche 1, 2, 3 oder 4, dadurch gekennzeichnet, daß die Abstände zwischen benachbarten Fingern, d. h. die Schlitzbreiten, ungefähr 38 μm (1, 5 mils) sind.

14. Leistungsteiler- und Summiererschaltkreis mit:

einem ersten dielektrischen Substrat;

einem ersten sich verjüngenden Streifen aus einem auf dem Substrat aufgebrachten elektrisch leitenden Material, wobei der Streifen ein breites Ende (6a) und ein schmales Ende (2a) und eine Mehrzahl von Schlitzen mit konstanter Breite aufweist, die sich entlang der Länge des sich verjüngenden Streifens von dem breiten Ende zu dem schmalen Ende erstrecken und eine Mehrzahl von ersten Fingern definieren, wobei die Breite der Schlitze genügend klein ist, um die kopplung zwischen benachbarten Fingern zu verbessern;

ersten Widerstandseinrichtungen zum elektrischen Verbinden benachbarter erster Finger;

Einrichtungen (30) zum Zuführen eines ersten Signals zu dem schmalen Ende (2a) des sich verjüngenden Streifens;

einem zweiten dielektrischen Substrat;

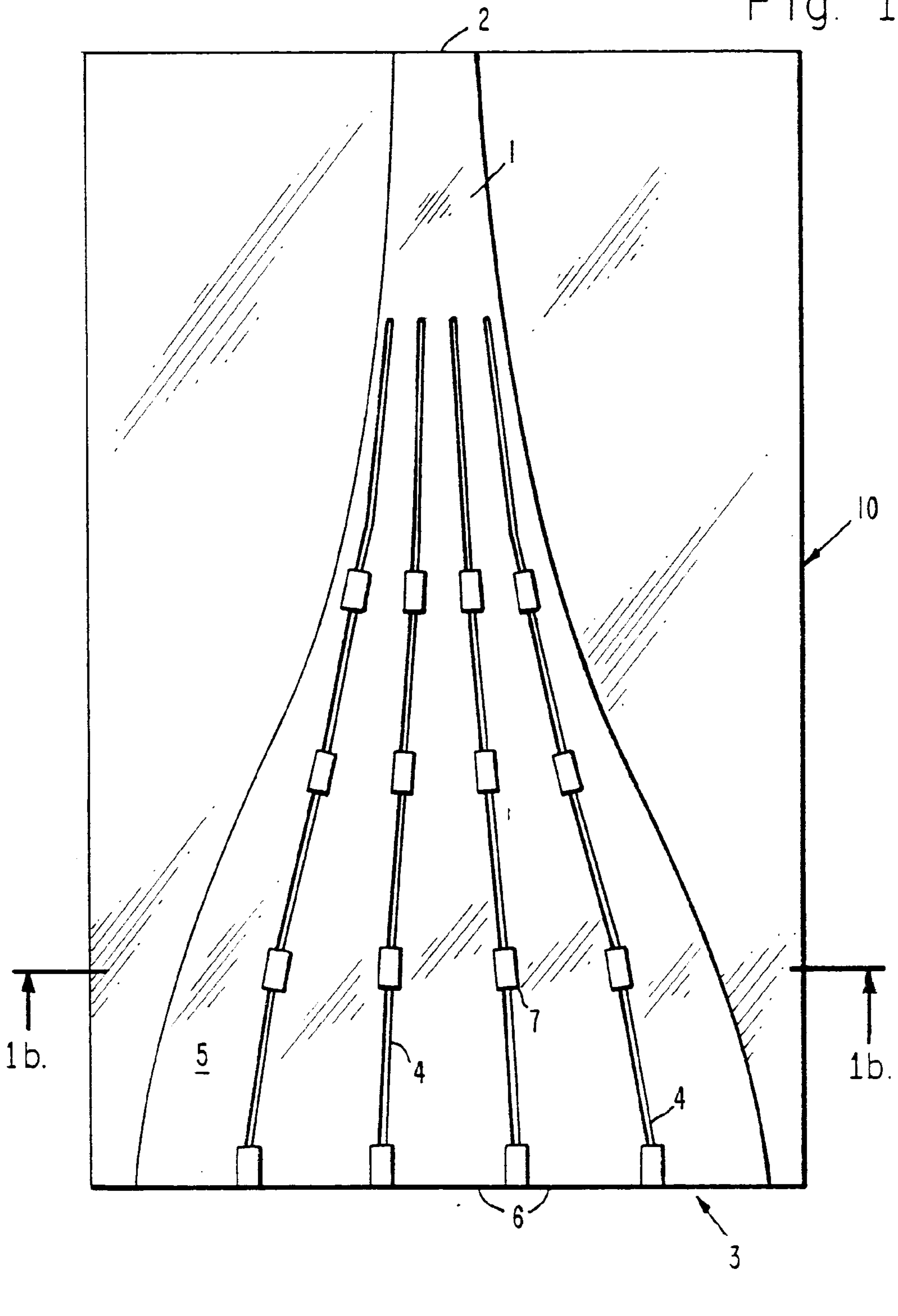
einem zweiten sich verjüngenden Streifen von auf dem zweiten Substrat aufgebrachten elektrisch leitendem Material, wobei der zweite Streifen ein breites Ende (6b), ein schmales Ende (2b) und eine Mehrzahl von Schlitzen mit konstanter Breite aufweist, die sich über die Länge des zweiten sich verjüngenden Streifens von dem breiten Ende zu dem schmalen Ende erstrecken und eine Mehrzahl von zweiten Fingern definieren, wobei die Breite der Schlitze genügend klein ist, um die kopplung zwischen benachbarten Fingern zu verbessern;

zweiten Widerstandseinrichtungen zum elektrischen Verbinden benachbarter Finger der zweiten Finger; und

Signaltranslationseinrichtungen (32), die elektrisch mit einander entsprechenden Paaren der ersten und zweiten Finger verbunden sind.

15. Leistungsteiler- und Summiererschaltkreis nach Anspruch 14, wobei die Translationseinrichtungen eine Mehrzahl von Verstärkern (32) umfassen.

Fig. 1a.



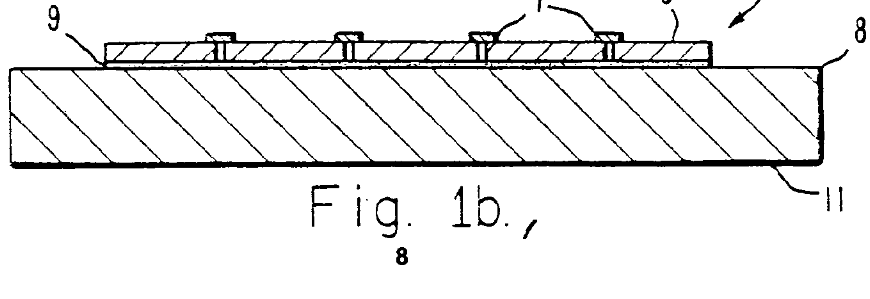


Fig. 1b.

Fig. 2.

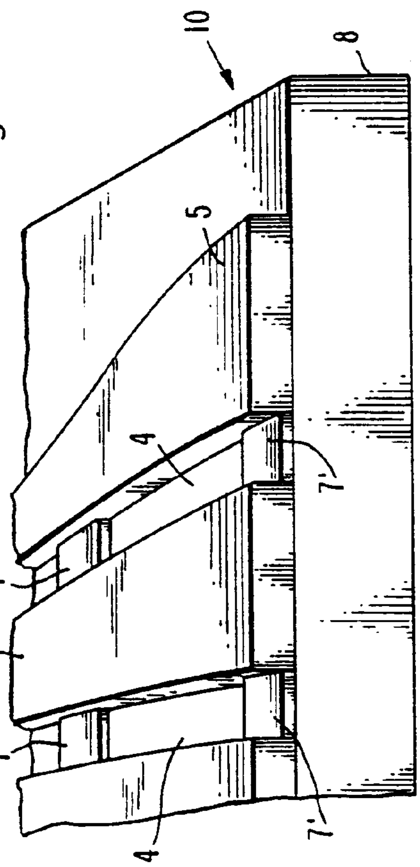
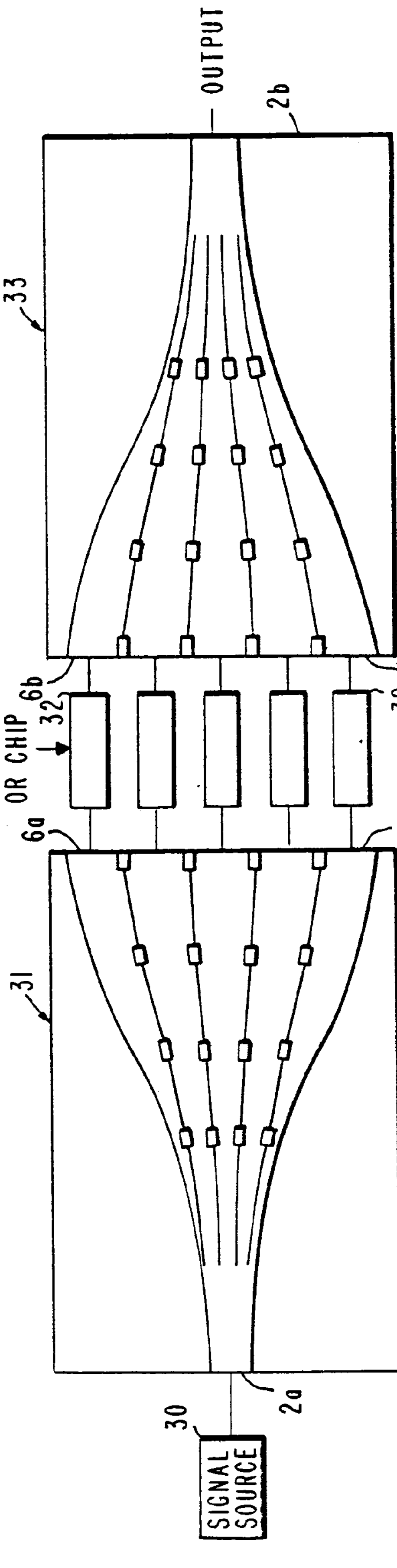

10
8
5
4
7
7'
5
7'
4
7'

Fig. 3.


OUTPUT
2b
33
6b
6b
32
32
AMPLIFIER OR CHIP
6a
6a
31
2a
30
SIGNAL SOURCE