(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 May 2009 (28.05.2009)

PCT

(10) International Publication Number
WO 2009/066992 A2

(51) International Patent Classification:
G01N 27/22 (2006.01) *G01N 27/26* (2006.01)

(21) International Application Number:
PCT/MY2008/000158

(22) International Filing Date:
24 November 2008 (24.11.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI 20072088 23 November 2007 (23.11.2007) MY

(71) Applicant *(for all designated States except US)*: **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **TAMSIR, Agus Santoso** [ID/ID]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **MANUT, Azrif** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **ALIAS, Dzulindah Muhamad** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **SULAIMAN, Suraya** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY). **ZAKARIA, Azlan** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Bukit Jalil, 57000 Kuala Lumpur (MY).

(74) Agent: **SIAW, Timothy**; Shearn Delamore & Co., 7th Floor, Wisma Hamzah-Kwong Hing, No. 1, Leboh Ampang, 50100 Kuala Lumpur (MY).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report*

(54) Title: CAPACITIVE SENSOR

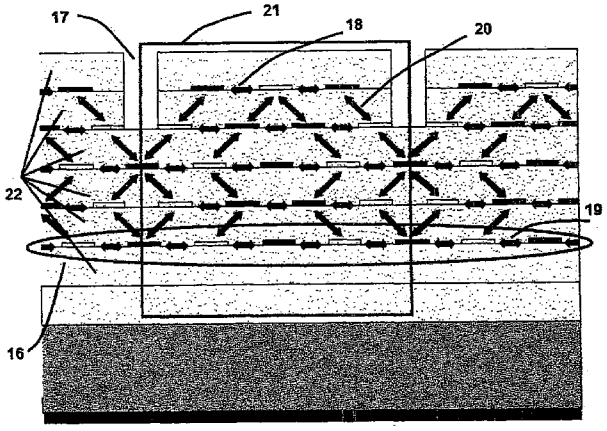


FIGURE 2

(57) Abstract: A capacitive sensor comprises of electrodes interdigitated fingers in multiple insulating layers for measuring moisture content.

WO 2009/066992 A2

Capacitive Sensor

Field of the Invention

The present invention relates to a capacitive sensor, particularly it relates to an improved capacitive sensor for measuring humidity and moisture.

Background of the Invention

In general, capacitive moisture sensor comprises of a pair of electrodes with moisture-sensitive material such as polymer or ceramic interposed therebetween. The dielectric constant of the material which also the capacitance between the two electrodes varies in response to ambient moisture. Hence, the moisture content can be determined by means of a capacitive measurement.

The measurement of humidity and moisture by using capacitive sensor are known. In US6,445,56 and US 6,628,501, there is provided a capacitive sensor using one layer electrodes placed on a membrane and bulk silicon substrate.

Summary of the Invention

It is an object of the present invention to provide an improved capacitive sensor for measuring humidity and moisture with multiple layers of interdigitated electrodes for higher capacitance sensitivity.

The capacitive sensor according to the present invention are defined with two, three, four and five layers of electrodes. The combinations of positive and negative electrodes within each porous insulating layers are arranged to be interdigitated to the adjacent layer.

By having the multiple layer of electrodes in each insulating layer, a deeper and wider penetration area of water vapor absorption capability. Hence, the total capacitance and the sensor sensitivity increase. This type of sensor could measure the water vapor and soil water.

Brief Description of the Drawings

The above description of the present invention is further described by way of example and with reference to the accompanying drawings in which:

Figure 1 illustrates one layer electrode interdigitated fingers.

Figure 2 illustrates multi layers electrode interdigitated fingers with trench.

Figure 3 illustrates two layers electrode interdigitated fingers with different electrode arrangement: 3(a) without trench; 3(b) with trench; 3(c) without trench; and 3(d) without trench.

Figure 4 illustrates three layers electrode interdigitated fingers with different electrode arrangement: 4(a) without trench; and 4(b) with trench.

Figure 5 illustrates four layers electrode interdigitated fingers with different electrode arrangement: 5(a) with trench; and 5(b) without trench.

Figure 6 illustrates five layers electrode interdigitated fingers with different electrode arrangement: 6(a) with trench; and 6(b) without trench.

Detailed Description of the Present Invention

The present invention will now be described more specifically with reference to the following embodiments. It is to be noted that the following descriptions of preferred embodiments of the present invention are presented herein for purpose of illustration and description only.

The structure of one-layer electrode interdigitated fingers is shown in Figure 1. It comprises a positive electrode (1) and a negative electrode (2) located between first insulating layer (3) and second insulating layer (4). The insulating layers are of porous and moisture-sensitive material preferably polyimide. The capacitance between the electrodes and the capacitance between the layers as illustrated in Figure 1 wherein: 12 represents the capacitance between the positive and negative electrodes (1,2) in the first insulating layer (3); 11 represents the capacitance between the electrodes (1,2) in the second insulating layer; 13 represent the capacitance between the electrodes (1,2) in silicon depletion layer (8),; 14 represents the capacitance between positive or negative electrode and ground (10) in the second insulating layer; and 15 represents the capacitance between either one of the electrodes (1,2) and ground in silicon depletion layer (8).

As explained above, it is a preferred embodiment of the present invention to have the electrode interdigitated fingers (16) in multiple insulating layers as shown in Figure 2. The structure as shown in Figure 2 comprises bulk semiconductor substrate (9), preferably silicon, a multiple insulating layers (22) with a plurality of electrodes and a plurality of trenches (17).

By having the structure as shown in Figure 2, the total capacitance and the sensitivity increase. The arrangement of the positive and the

negative electrodes which are interdigitated to each other will automatically construct a periodic capacitance cluster (21). It is to be noted that different arrangements of electrodes will construct a different cluster capacitance. The horizontal double arrows (18, 19) and diagonal arrows shown in Figure 2 represent the capacitance between the positive and the negative electrodes.

In another embodiment, the interdigitated electrode fingers are arranged into two, three, four and five insulating layers. Two layers electrode interdigitated fingers are shown in Figures 3a, 3b, 3c, and 3d with different periodic capacitance clusters, in which Figure 3b having a plurality of trenches (17) separating and enlarging the region of the insulating layer. The trenches (17) on the structure allow more water vapour to enter into the underlying layers, thus improving the water vapour absorption. This structure is suitable for measuring moisture content in soil.

Further, in Figures 3a and 3b, it is shown that the positive and negative electrodes are placed side by side in each layer and arranged to be interdigitated to the adjacent layer. In Figure 3c and 3d, the electrodes are arranged at least one pair of either negative or positive electrodes are arranged side by side to each other pair in at least one insulating layer whereby the positive and the negative electrodes in the adjacent insulating layer are arranged side by side.

Three, four and five layers of electrode interdigitated finger are shown in Figures 4, 5 and 6 respectively whereby, different number of layers either with or without trenches give different type of cluster capacitance. The capacitance is measured with a read-out circuitry in an integrated circuits.

Claims

1. A capacitive sensor for measuring moisture comprising:
   a semiconductor substrate;
   a multiple insulating layers;
   a plurality of electrodes lying between the insulating layers; and
   a plurality of trenches separating the insulating layers.

2. The capacitive sensor for measuring moisture according to Claim 1 wherein
   the insulating layers are porous and of moisture-sensitive material having a dielectric constant that varies in response to moisture.

3. The capacitive sensor for measuring moisture according to Claim 2 wherein
   the moisture-sensitive material is preferably polyimide.

4. The capacitive sensor for measuring moisture according to Claim 1 wherein
   the electrodes are arranged in each insulating layer to be interdigitated to the adjacent insulating layer.

5. The capacitive sensor for measuring moisture according to Claim 1 wherein
   the trenches enlarging the insulating materials region for absorbing moisture.

6. A capacitive sensor for measuring moisture comprising:

a semiconductor substrate;

a multiple insulating layers; and

a plurality of electrodes lying between the insulating layers.

7. The capacitive sensor for measuring moisture according to Claim 6 wherein

the insulating layers are porous and of moisture-sensitive material having a dielectric constant that varies in response to moisture.

8. The capacitive sensor for measuring moisture according to Claim 7 wherein

the moisture-sensitive material is preferably polyimide.

9. The capacitive sensor for measuring moisture according to Claim 8 wherein

the electrodes are arranged in each insulating layer to be interdigitated to the adjacent insulating layer.

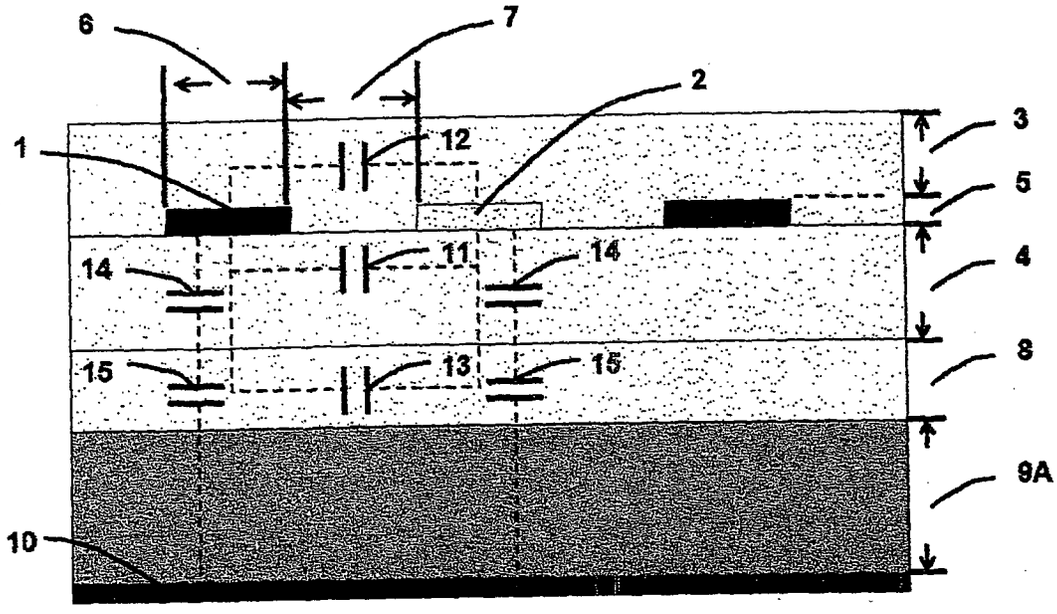


FIGURE 1

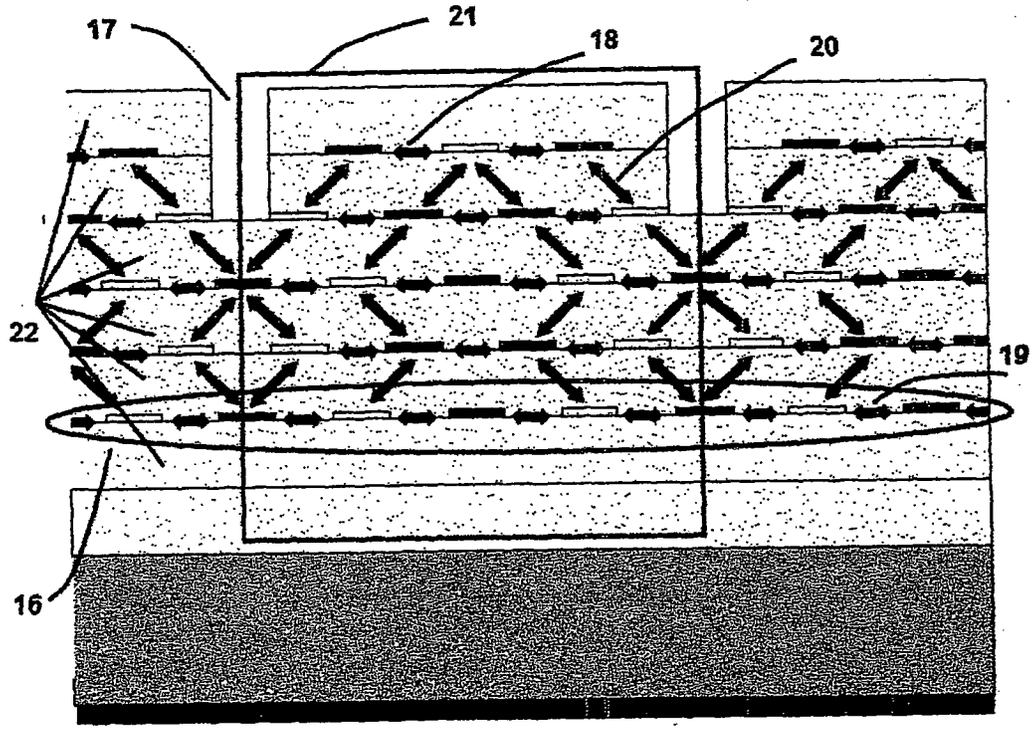
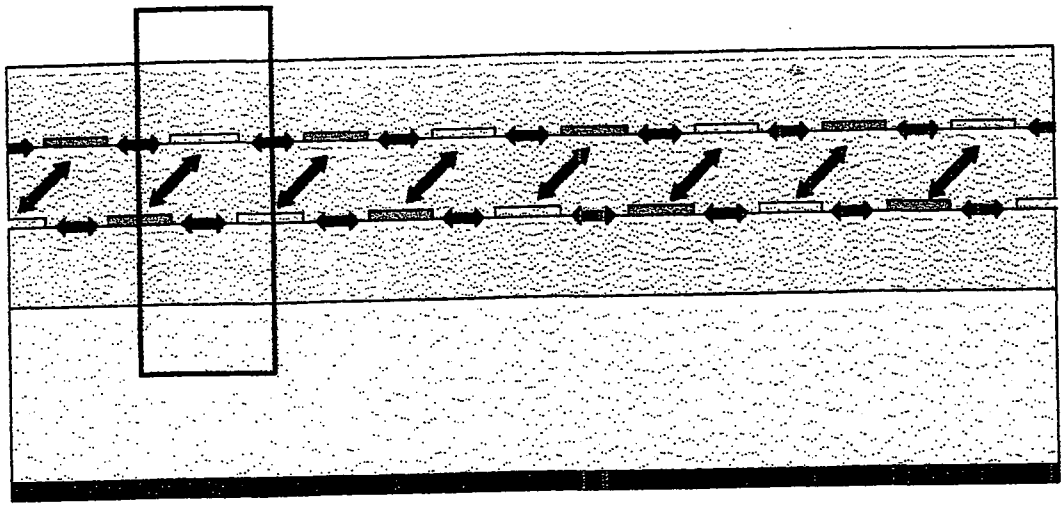
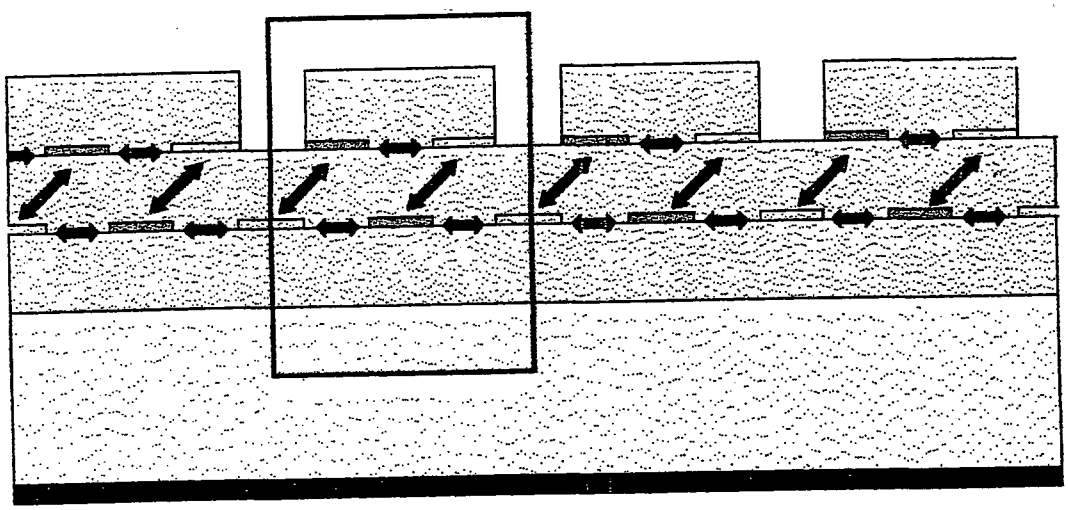


FIGURE 2

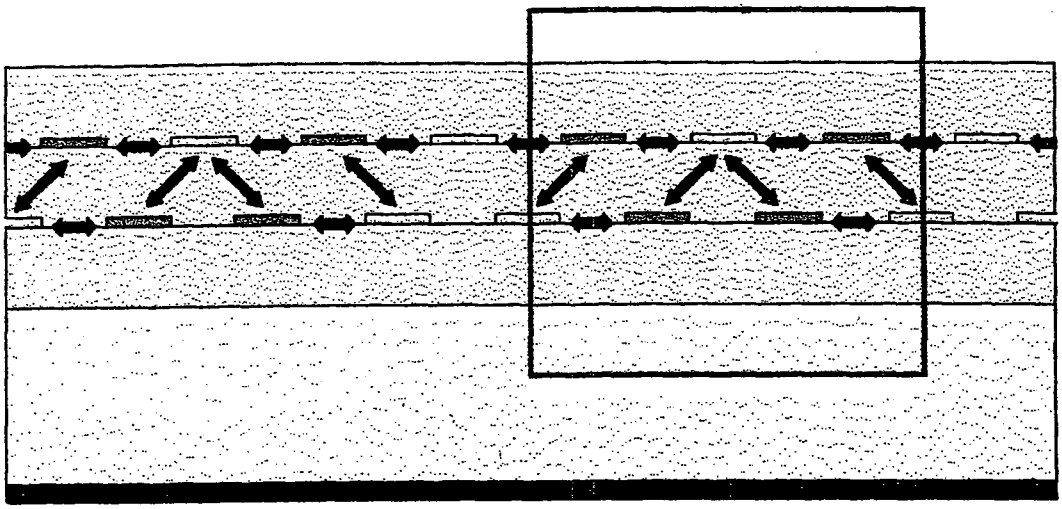


(a)

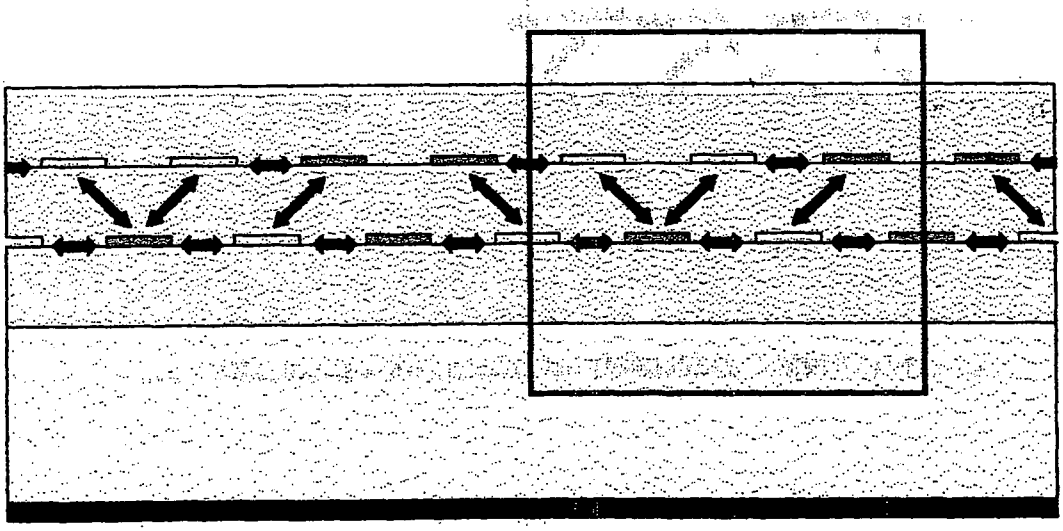


(b)

FIGURE 3

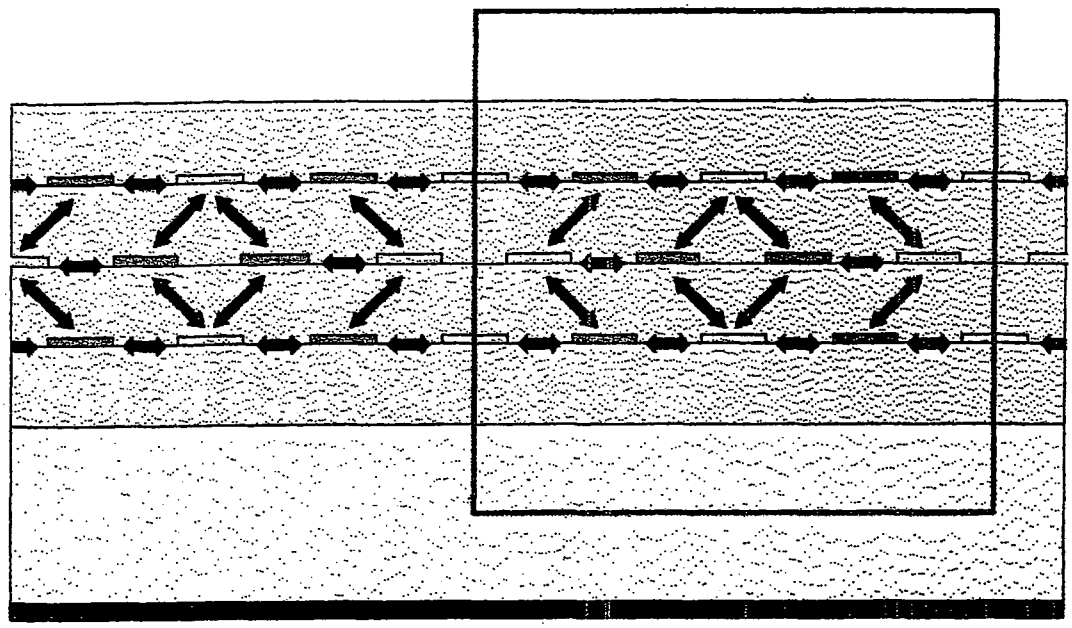


(c)

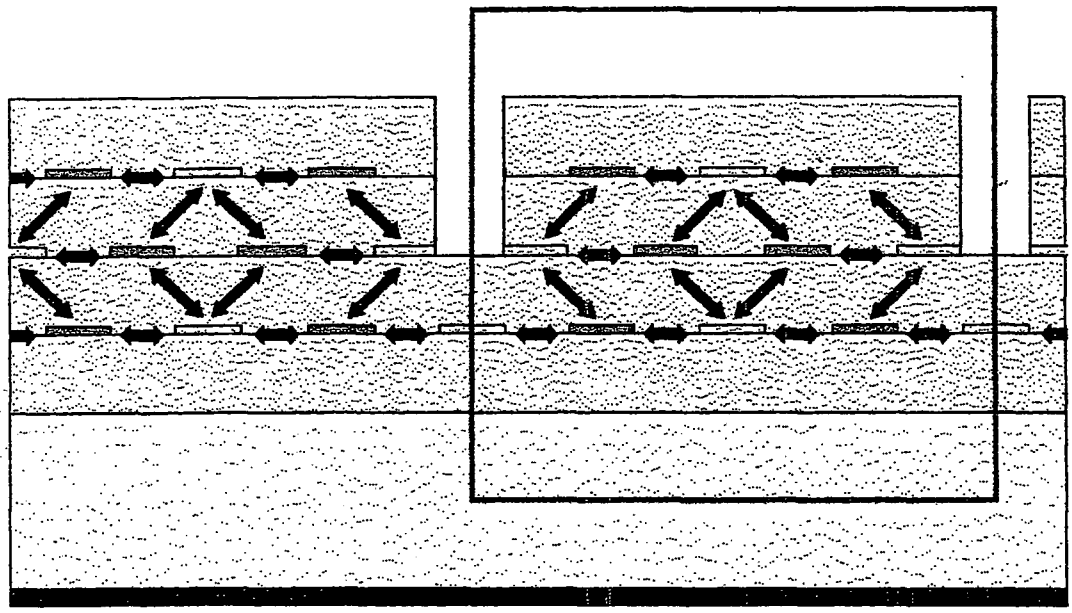


(d)

FIGURE 3 (continued)

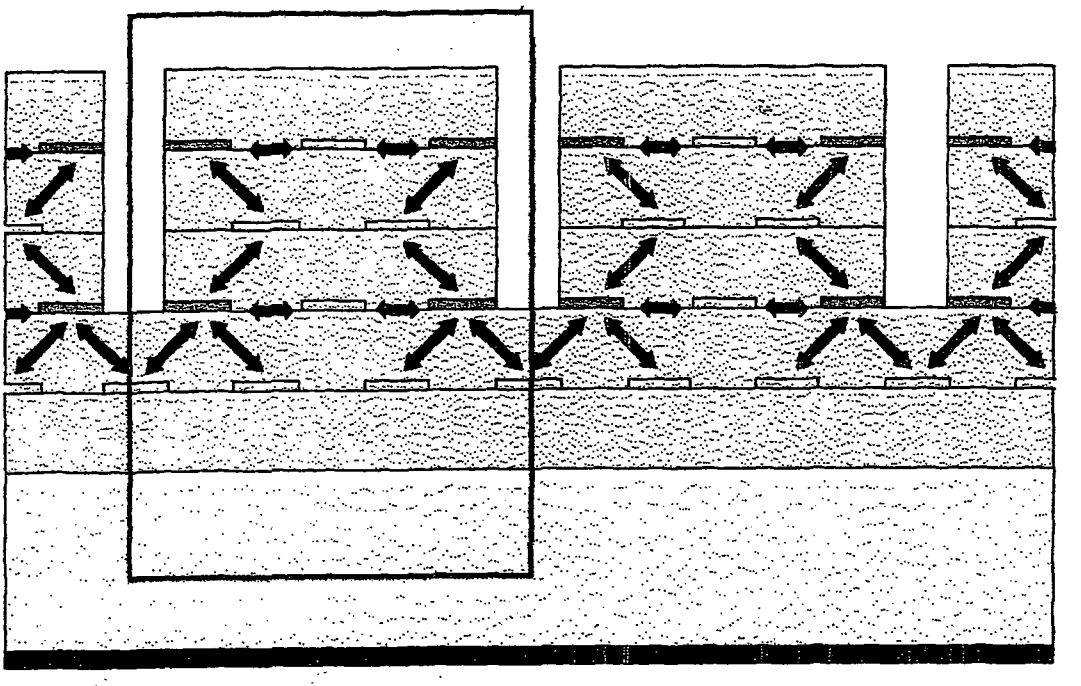


(a)

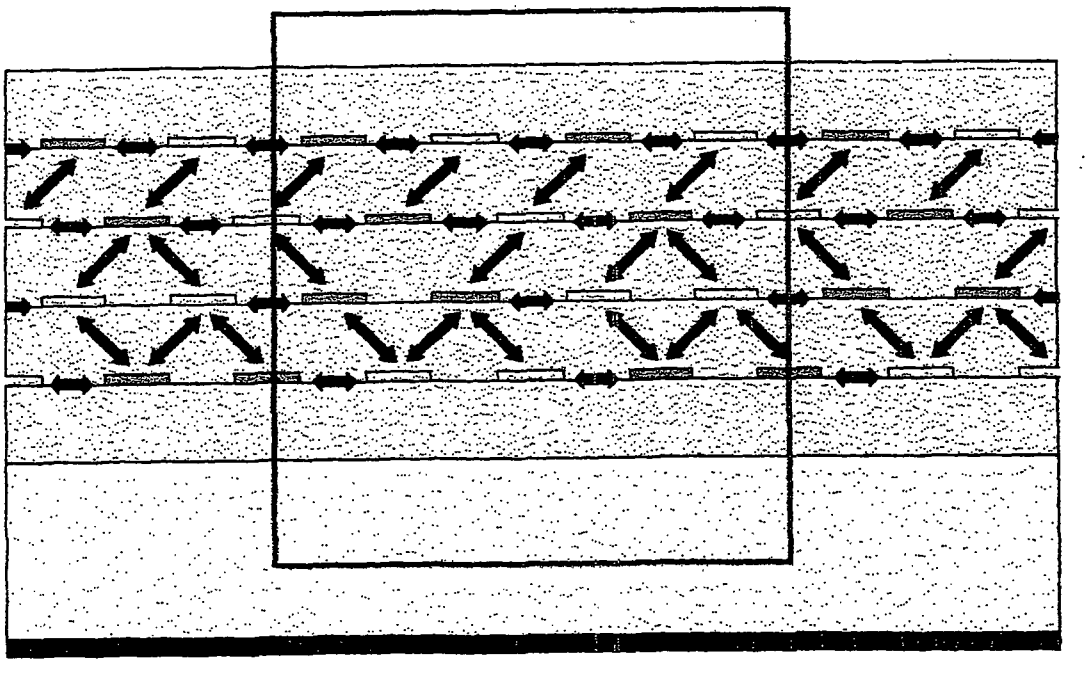


(b)

FIGURE 4

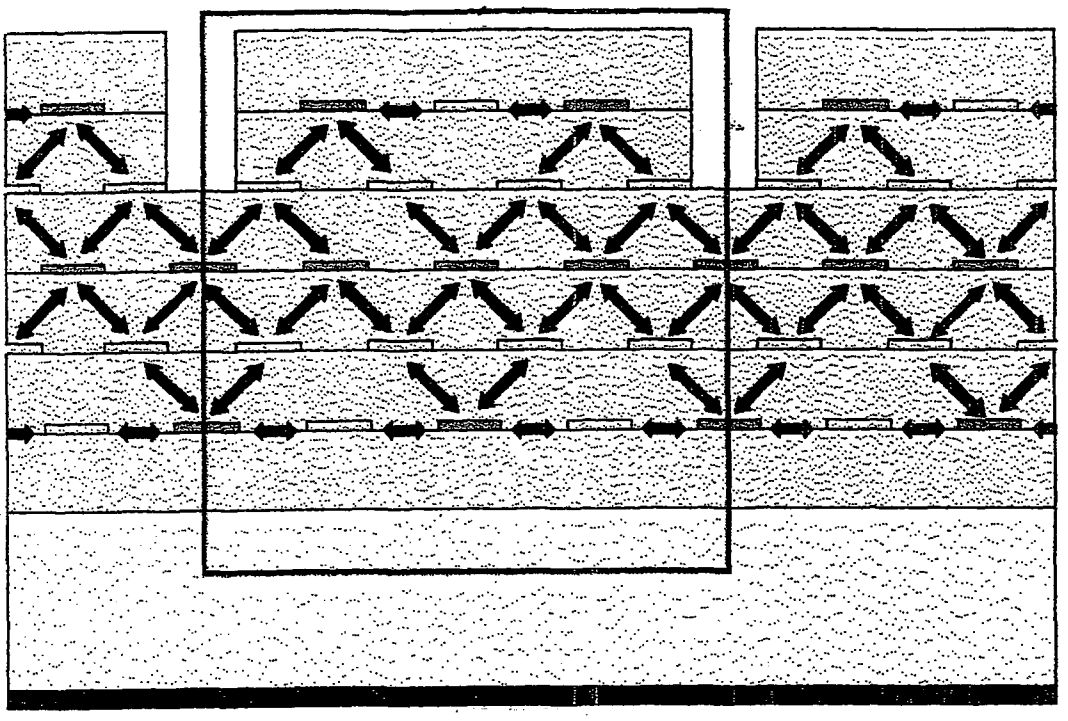


(a)

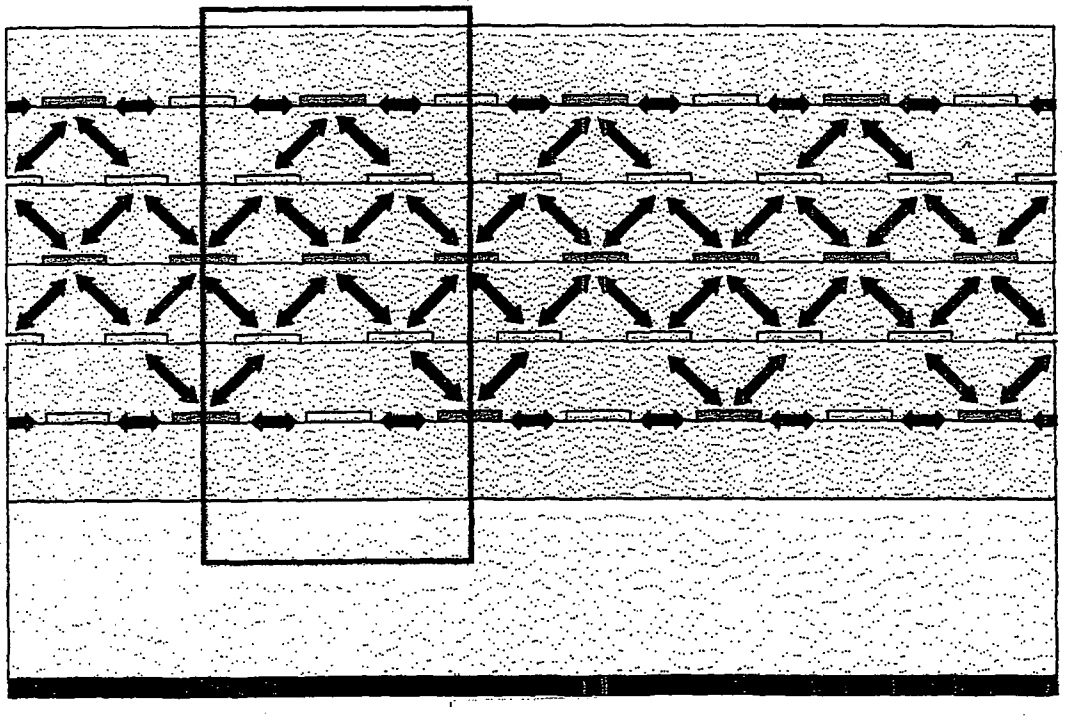


(b)

FIGURE 5.



(a)



(b)

FIGURE 6