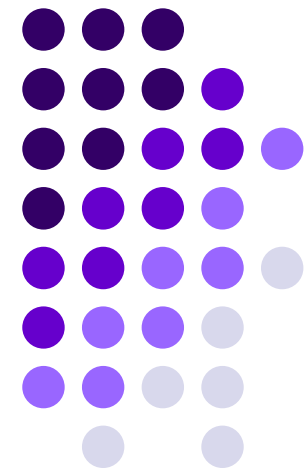
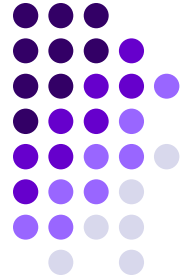


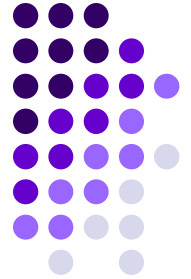
Senzori si traductoare



Cuprins 11

Senzori tactili

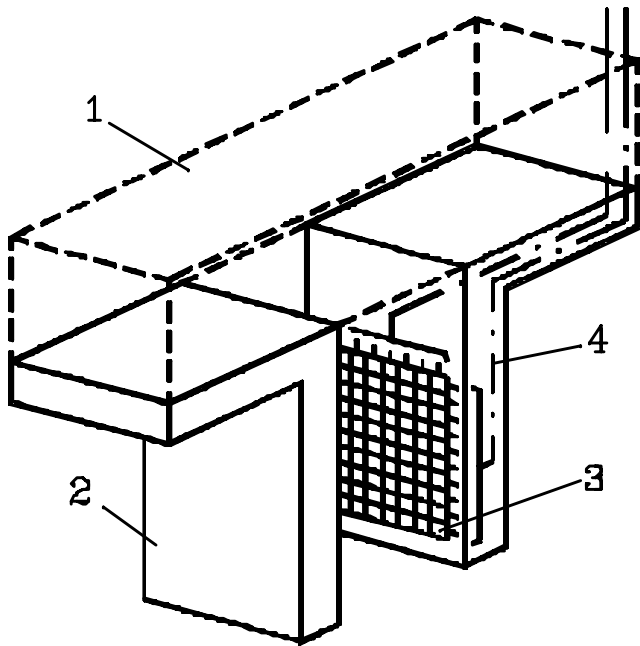




- Senzorii tactili imită posibilitățile senzitive ale mâinii umane;
- “pulpa” degetului - sensibilitatea este de $2\text{mg}/\text{mm}^2$
- suprafața dorsală a degetelor – sensibilitatea = $15\text{ mg}/\text{mm}^2$
- mâna stângă a unui virtuos al viorii:
 - efectueaza 580 atingeri ale coardelor / minut
 - 1180 de nivele de atingere între 1N și 5N

Problemele rezolvate:

- determinarea existenței contactului efector piesa prehensată;
- determinarea coordonatelor și suprafeței de contact;
- măsurarea forței de prehensare;
- înregistrarea distribuției efortului pe bacul efectorului;
- determinarea orientării piesei prehensate;
- determinarea alunecării piesei între bacurile DP
- determinarea proprietăților mecanice a pieselor prehensate

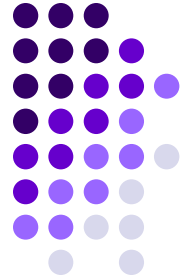


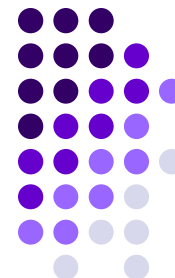
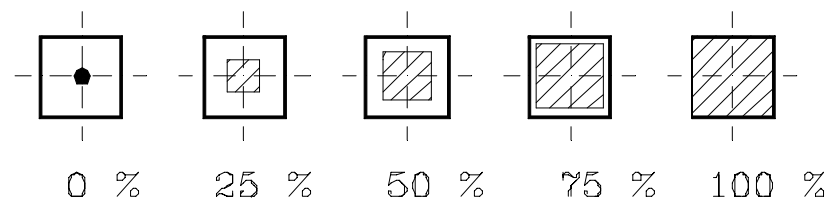
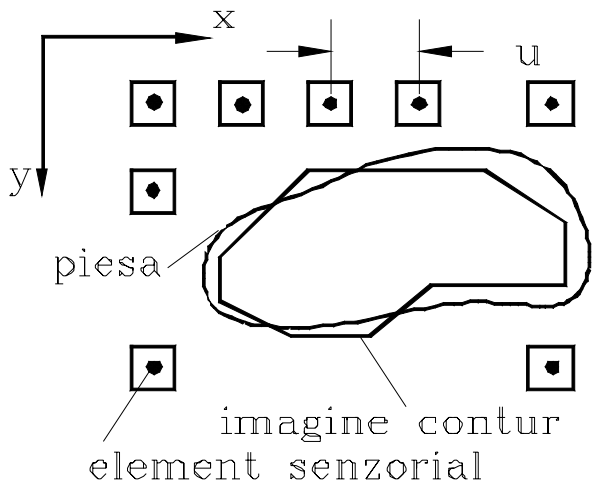
Locul matricii senzoriale:

1 – efector; 2 – bac; 3 – matrice senzorială; 4 – cale de informație

Informația poate fi obținută:

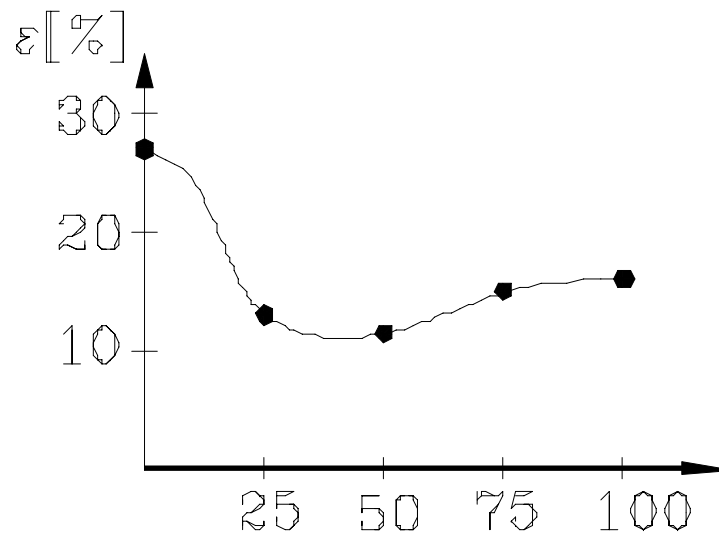
- printr-un ansamblu de celule elementare dispuse în matrice;
- printr-o linie informațională analizată secvențial;
- printr-o tehnică ce livrează informațiile simultan.



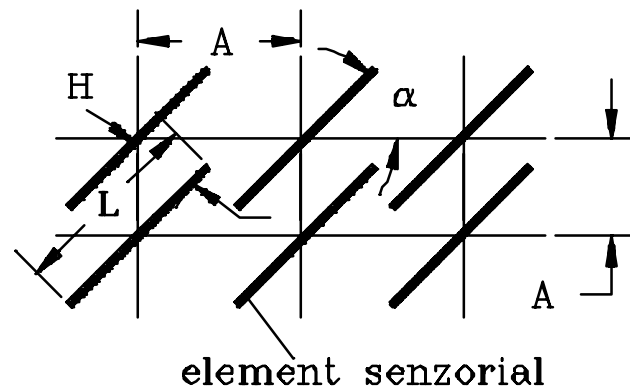
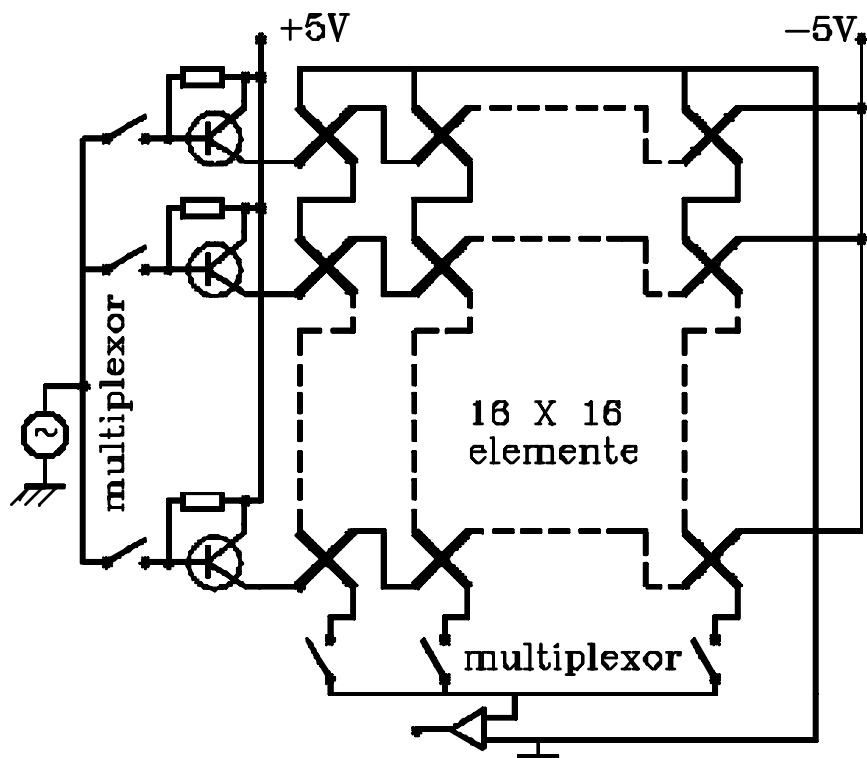
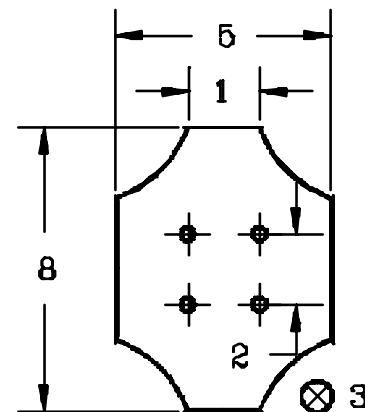
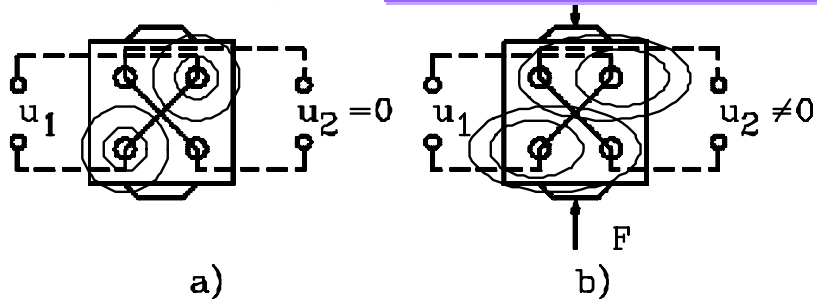


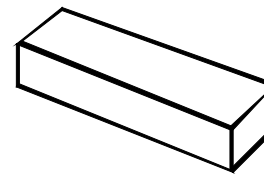
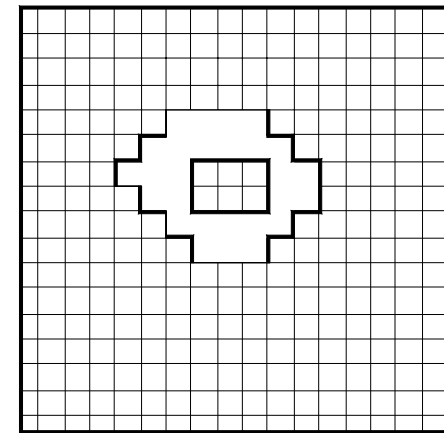
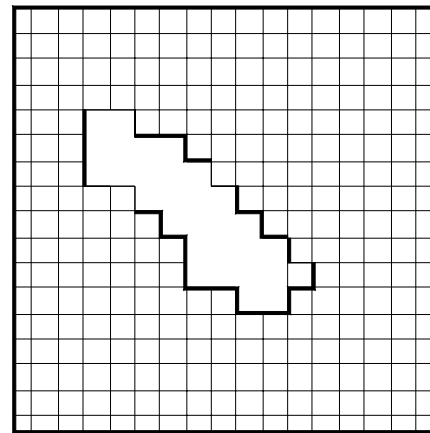
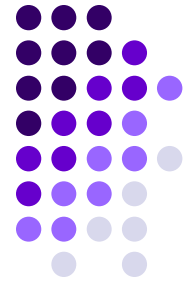
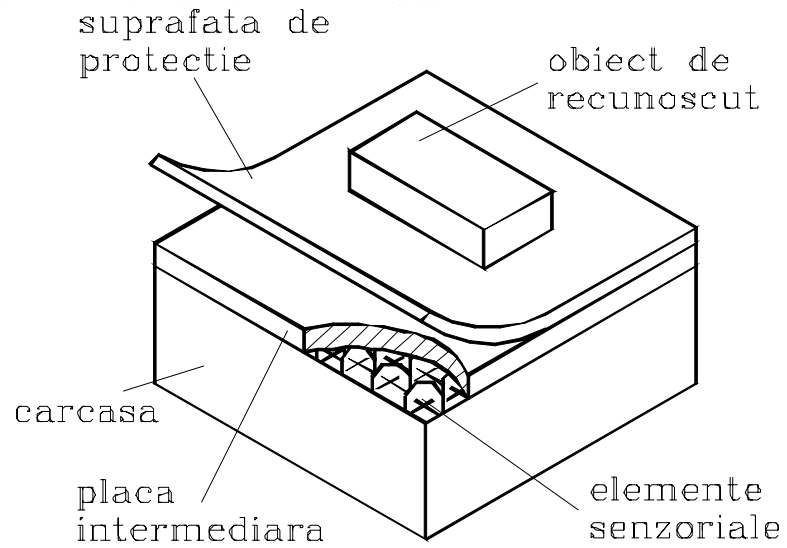
$\frac{1}{u}$ rezoluția a senzorului

$$\varepsilon = \frac{I_i + I_0 - A}{A} \cdot 100 \quad [\%]$$

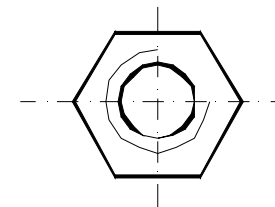


Senzori tactili magnetoelastici



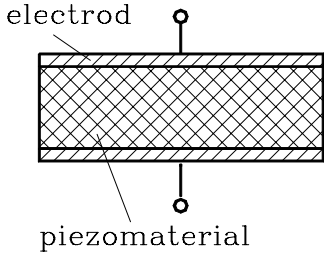
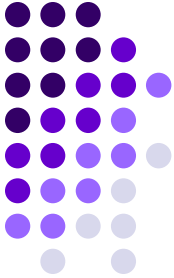


a)



b)

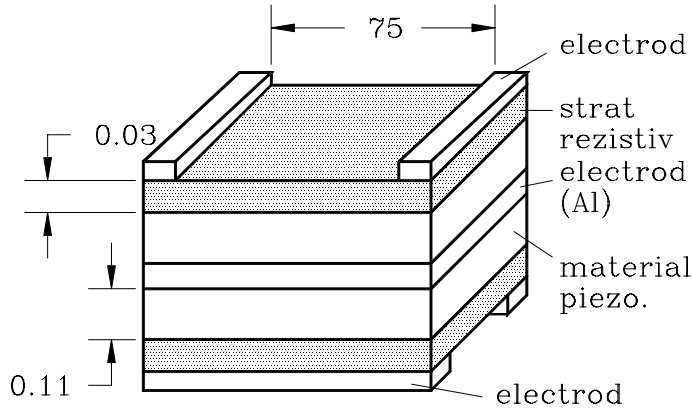
Senzori tactili piezoelectrice



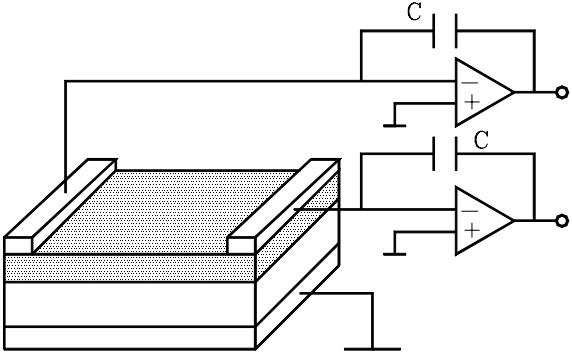
$$U = \frac{d \cdot h}{\epsilon} \cdot \sigma$$

σ [N/mm²] este efortul mecanic în piezoelement,
 ϵ [F/m] este permitivitatea materialului,
 h [m] este grosimea piezoelementului,
 d [C/N] este constanta piezoelectrică

Element senzitiv piezoelectric

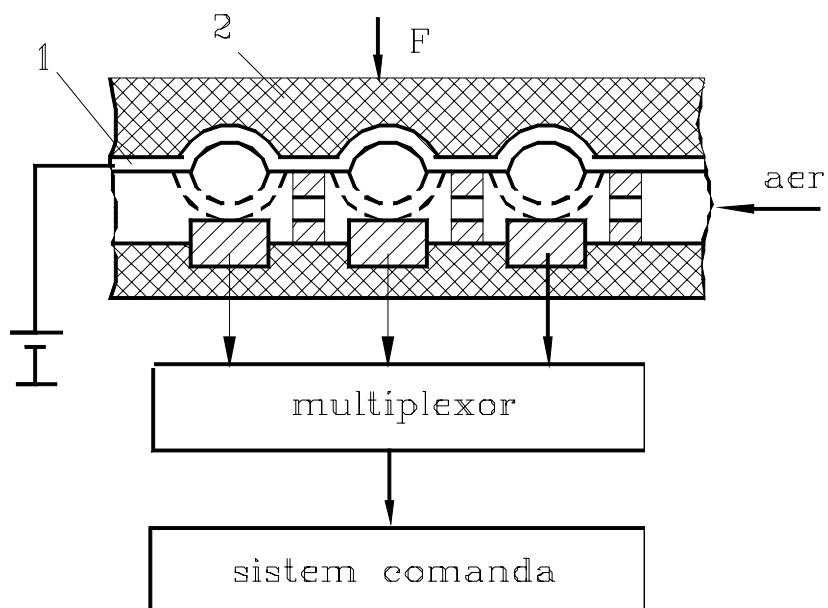
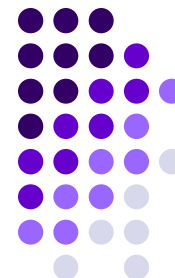


Senzor tactil piezoelectric

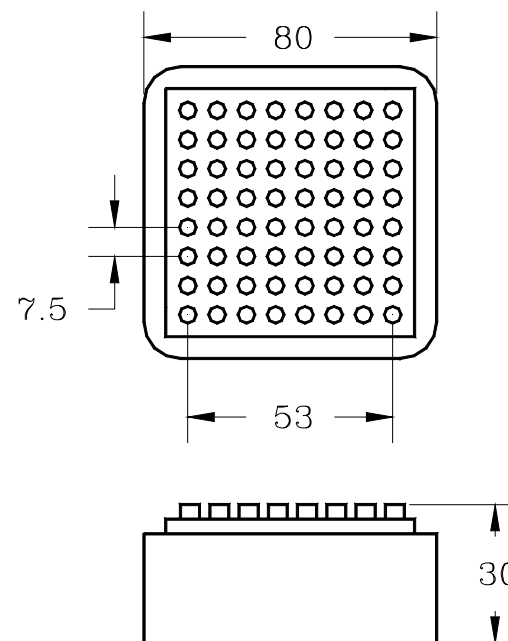


Schema electrică principală a circuitului de măsurare

Senzori tactili binari

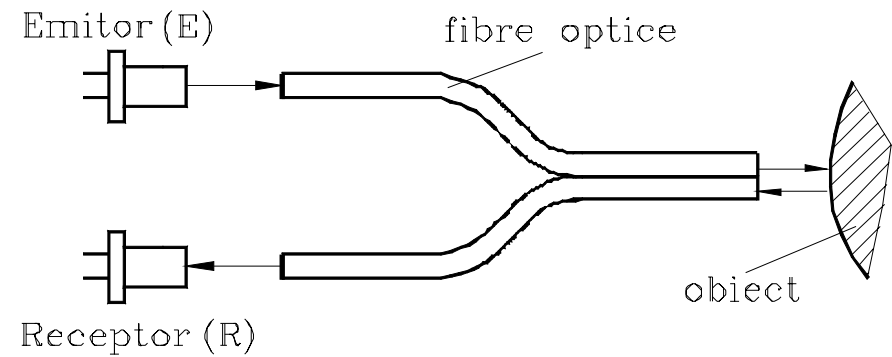
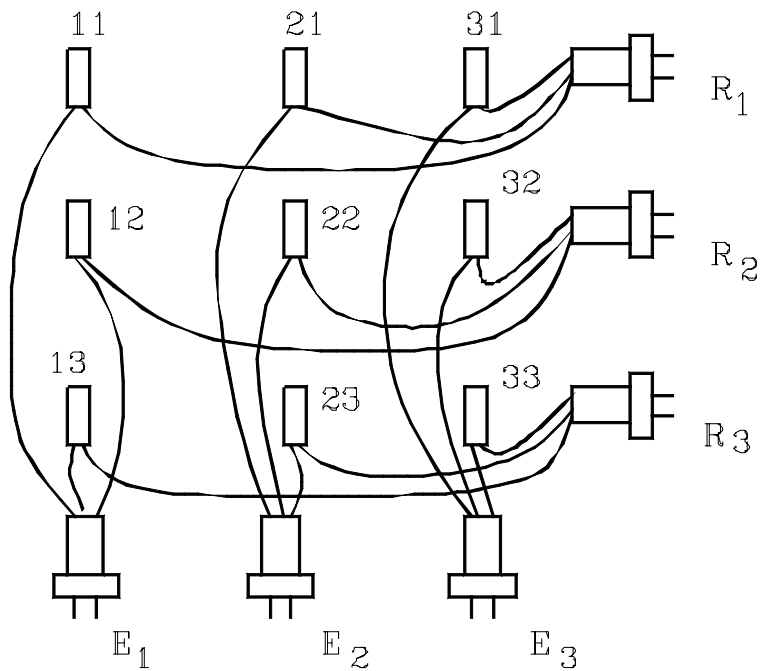
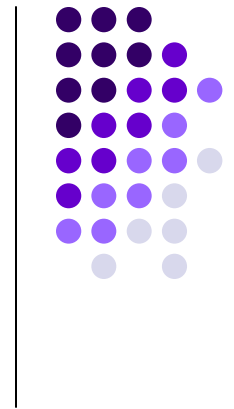
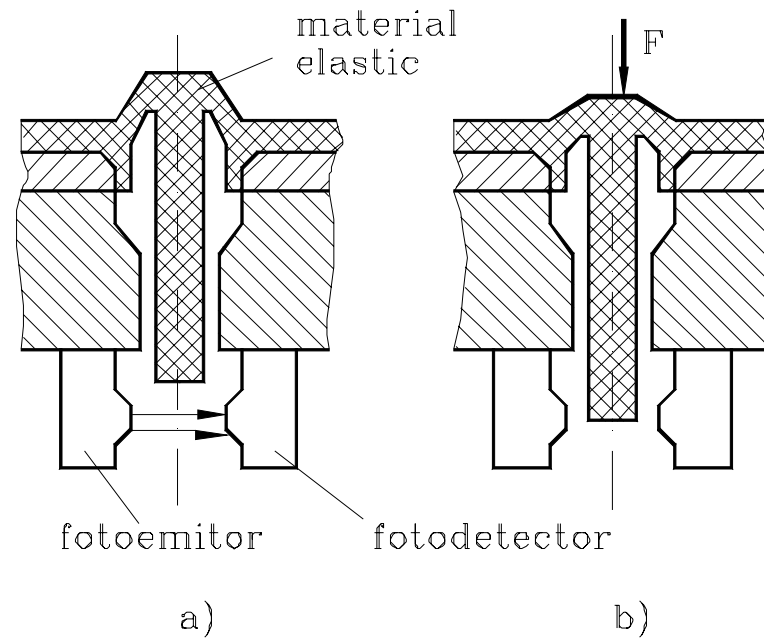


Senzor tactil binar (1 – membrană metalică; 2-material elastic)

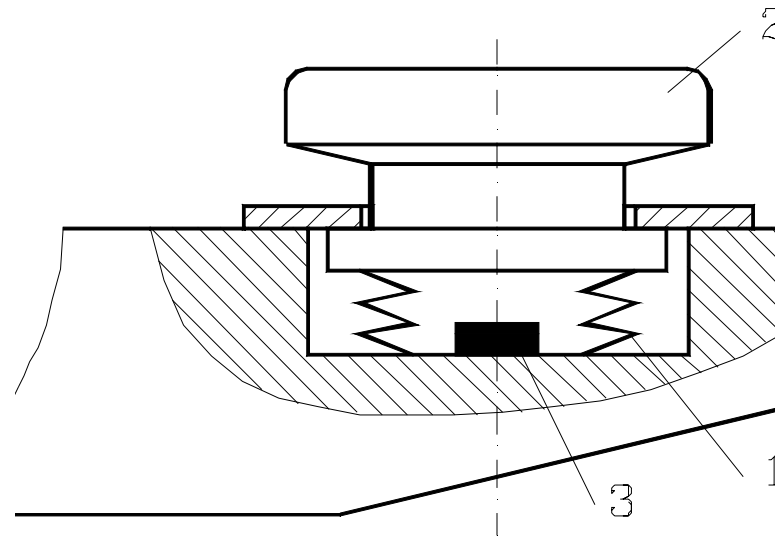


Dimensiuni de gabarit a unui senzor tactil matricial binar optic

- a) fără solicitare;
- b) cu solicitare exterioară

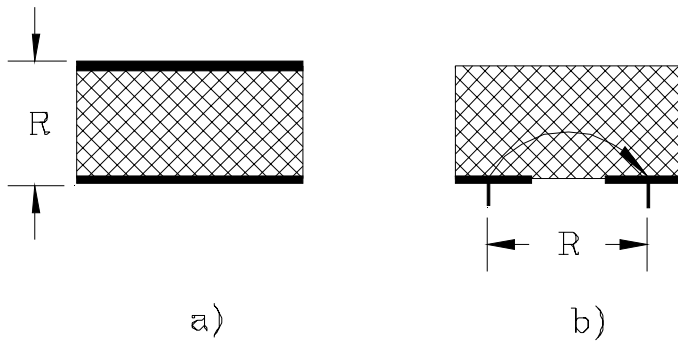
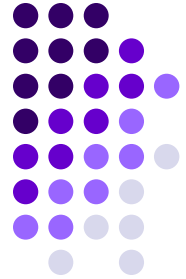


Senzori tactili inductivi

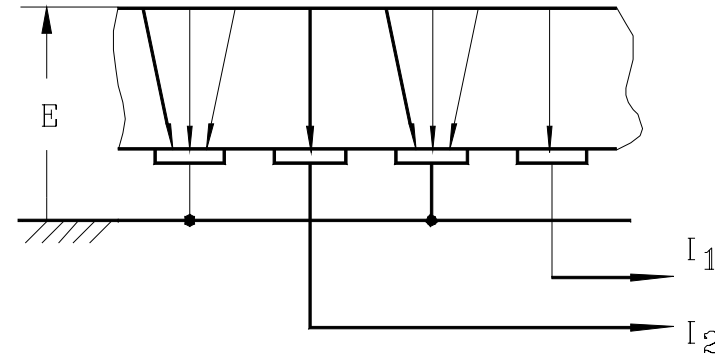


“Punct” sensibil într-o matrice tactilă
(1–arc; 2 – buton; 3 – traductor inductiv)

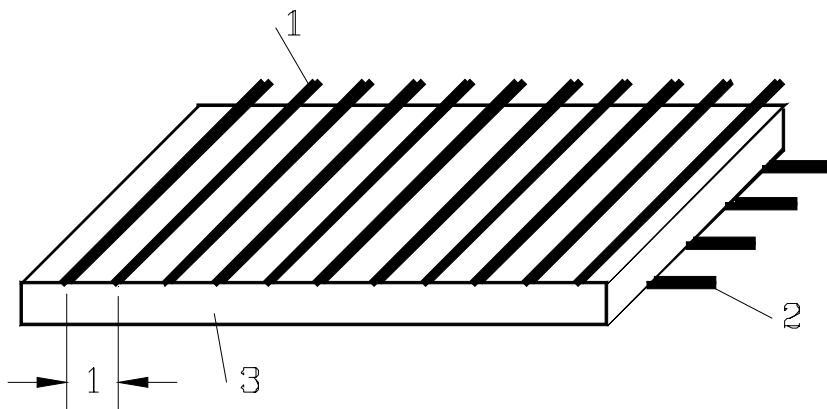
Senzori piezorezistivi



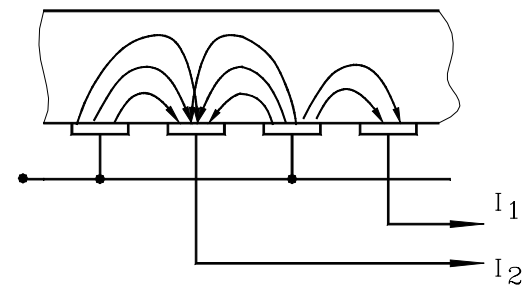
Tipuri de conductivitate:
transversală (a) și longitudinală (b)



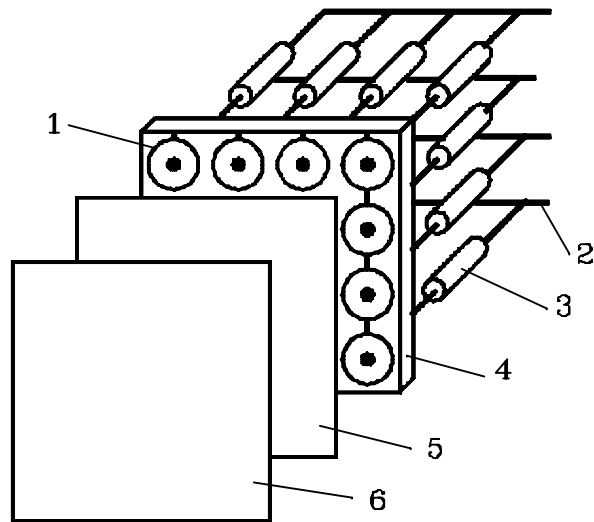
Conductivitatea transversală:
repartizarea liniilor de curent



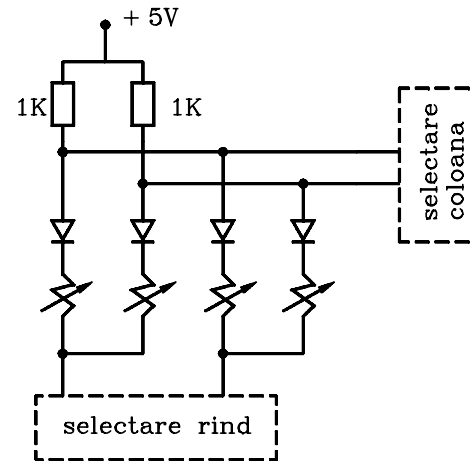
Matrice tactilă: 1- electrozi superiori; 2- electrozi inferiori; 3 – material piezorezistiv



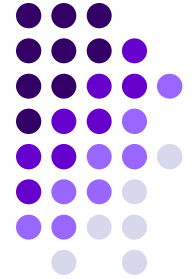
Repartizarea liniilor de curent pentru
conductivitatea longitudinală



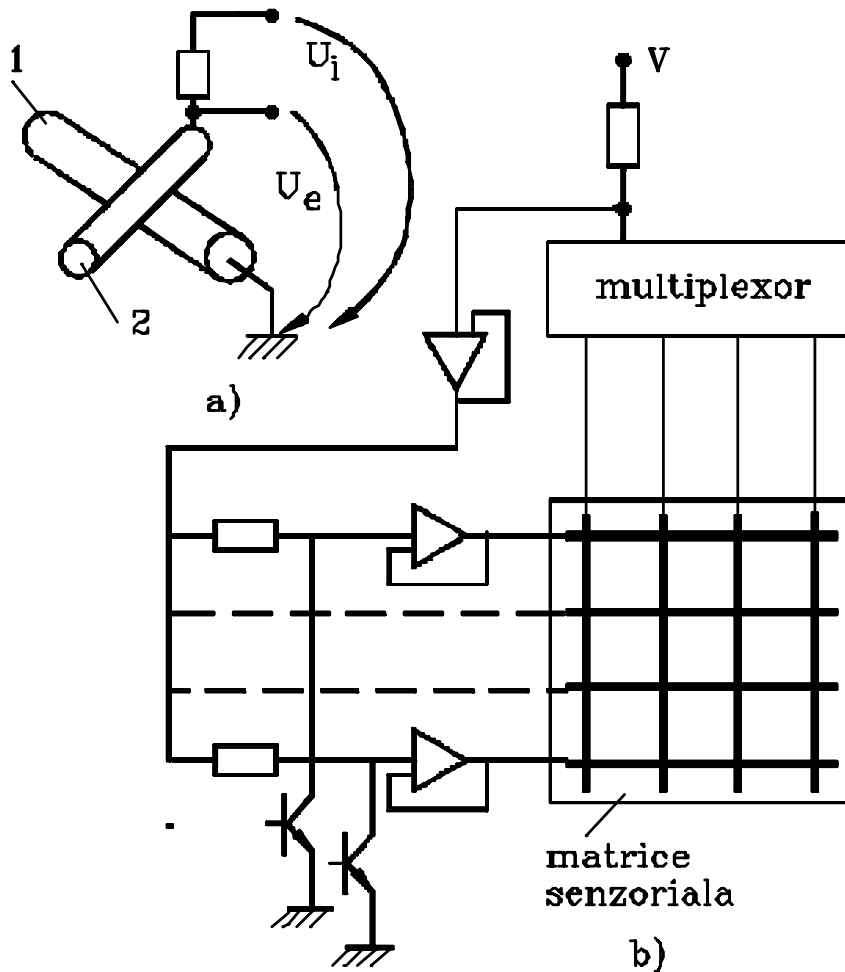
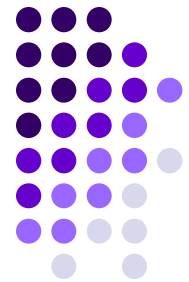
- 1-inel conductor;
- 2-linie matriceală;
- 3-dioda; 4-circuit imprimat;
- 5-material piezorezistiv;
- 6- material de protecție



Schema electrică a circuitului de măsurare



Senzori tactili pe baza de elastomeri

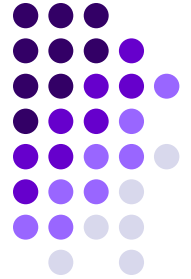
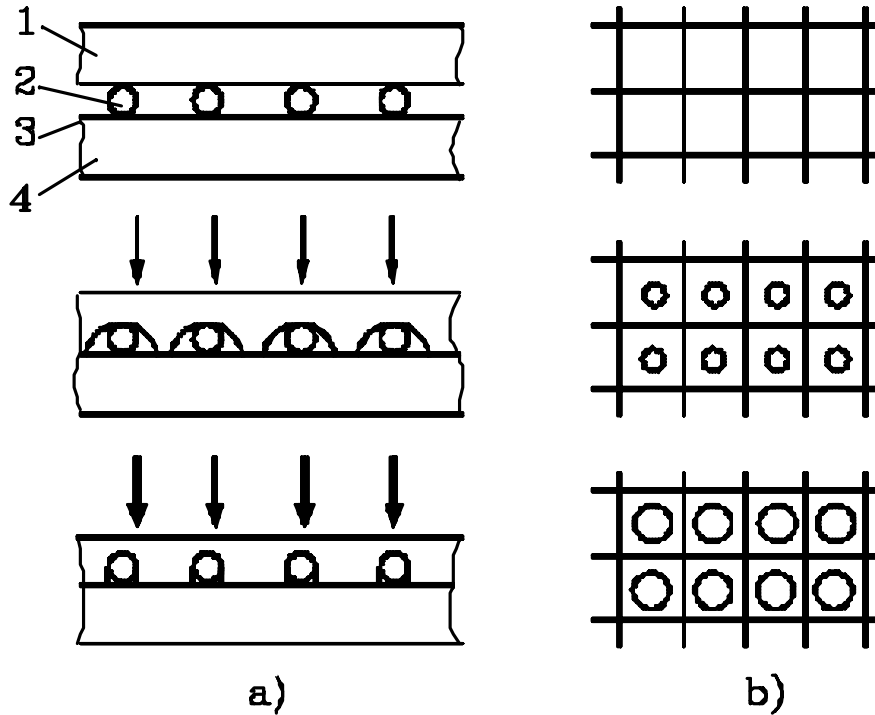


Matrice senzorială

1- electrod metalic; 2 – electrod din cauciuc siliconic:

a) principiul de funcționare;

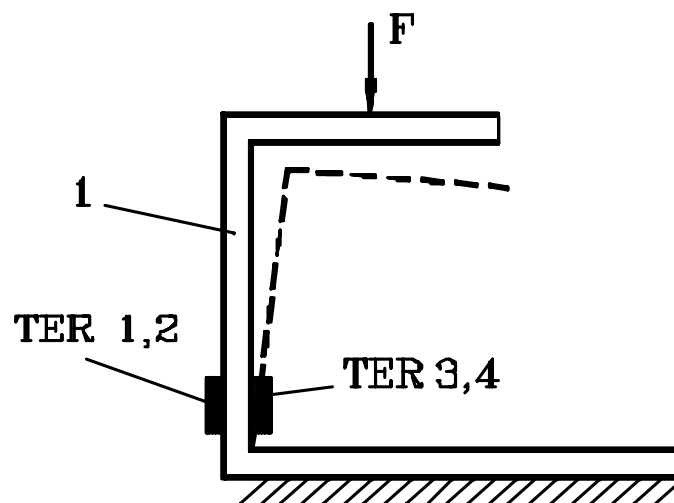
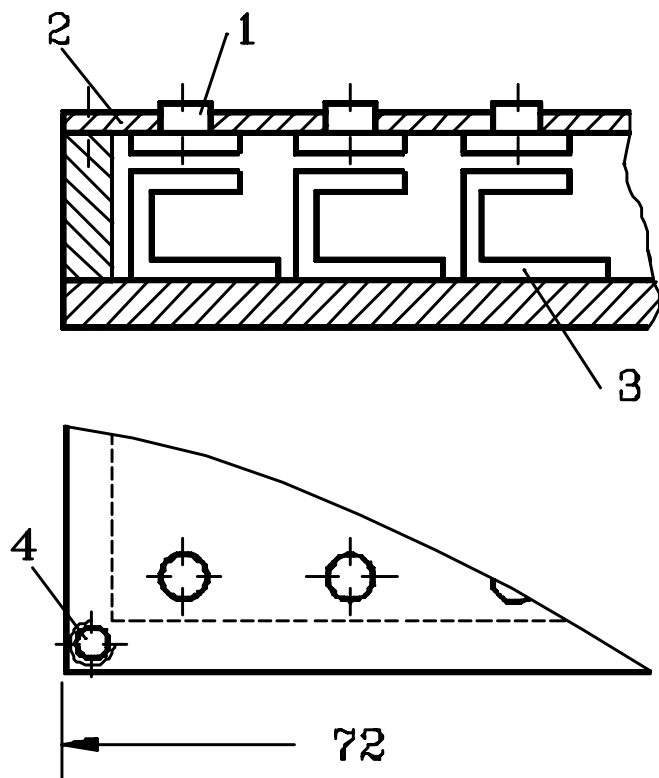
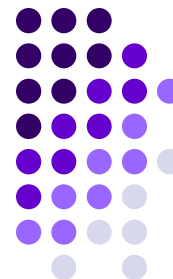
b) schema de măsurare



1- elastomer conductor; 2- izolator; 3- suprafața conductoare; 4 - suport izolator:

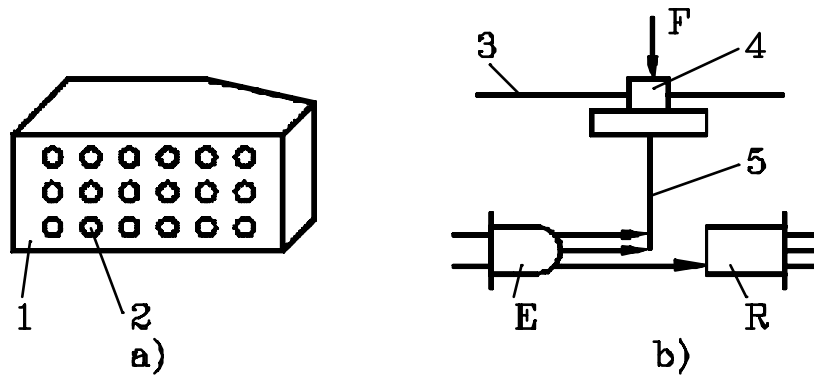
- a) structura și comportamentul în lipsa și prezența forței exterioare;
- b) suprafață de contact 1-3

Senzori tactili tensorezistivi

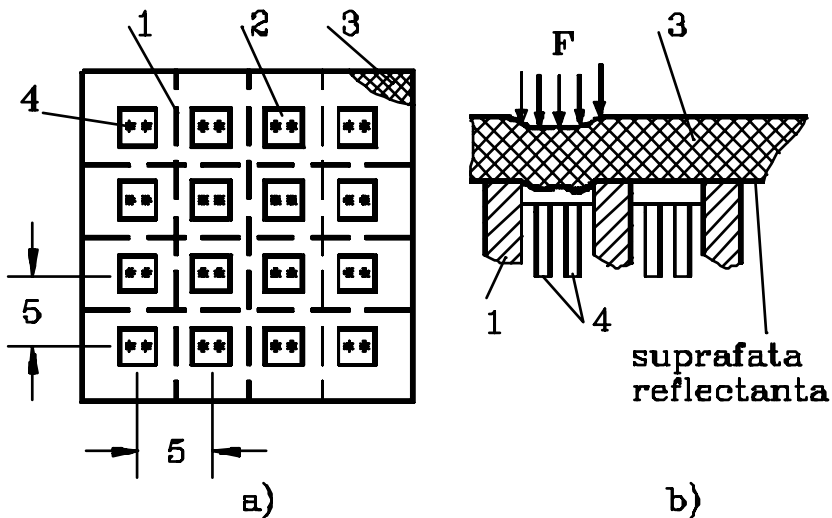


1- buton; 2 - membrană elastică; 3- element elastic primar; 4 - șurub

Senzori tactili optici

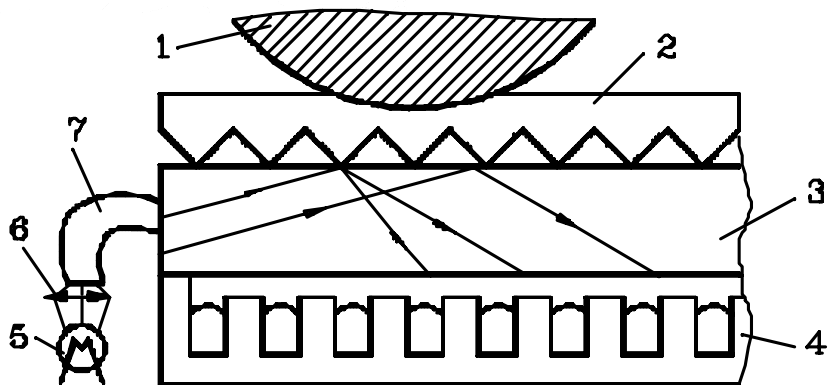
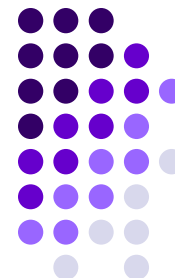


1 - bac; 2 – element sensibil; 3- membrană elastică; 4 - buton; 5- ecran
 a) aspect general; b) structura unui element sensibil

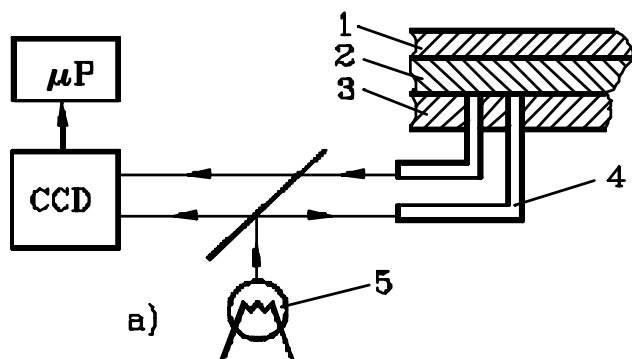


1- perete intermediar; 2- punct tactil; 3 - membrană elastică; 4 - fibre optice:

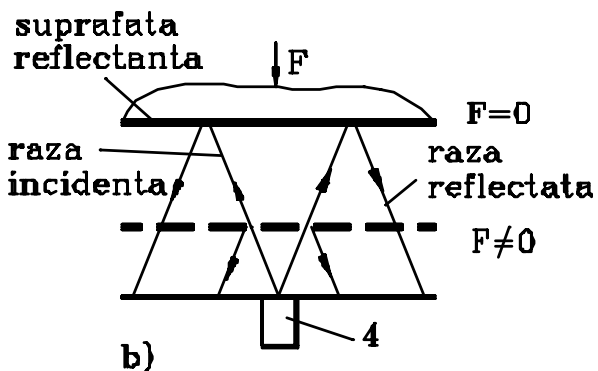
a) vedere generală; b) secțiune printr-un punct sensibil



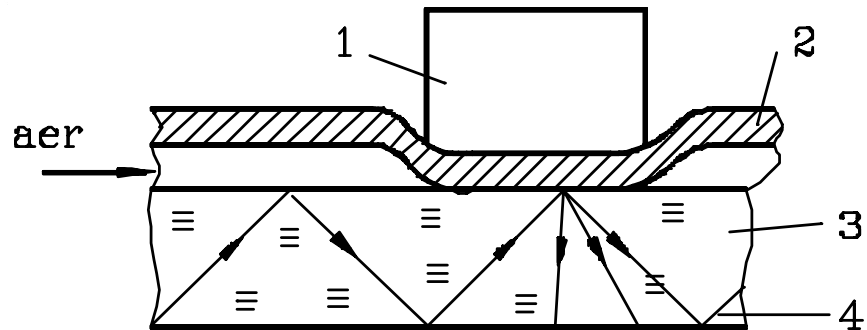
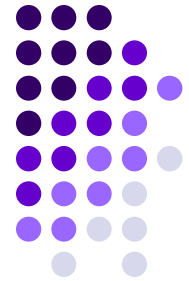
1 - obiect; 2- membrană elastică; 3 - material transparent; 4 - matrice cu fototranzistoare; 5 - sursă luminoasă; 6 - lentilă colimatoare; 7 - fibre optice



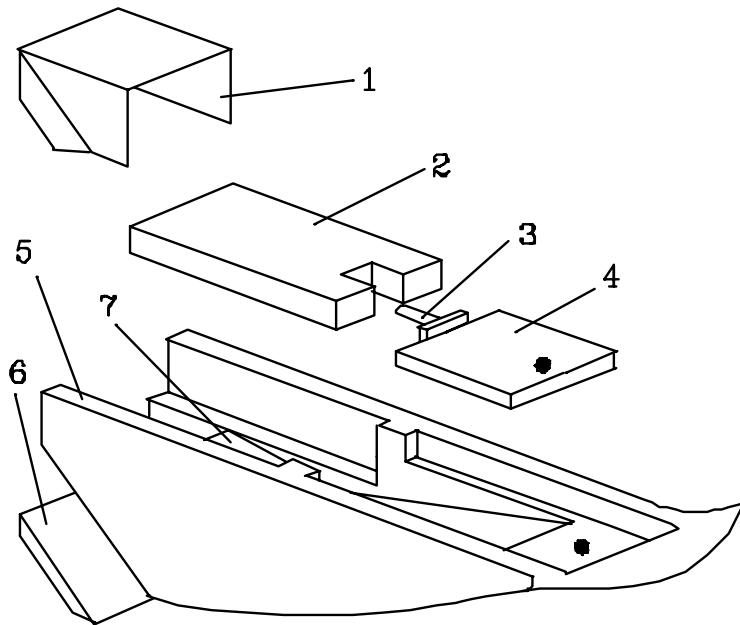
1-cauciuc siliconic; 2-cauciuc transparent; 3-rașină epoxidică; 4-fibra optică; 5-sursă de lumină:



a) elementele componente;
 b) principiul de funcționare

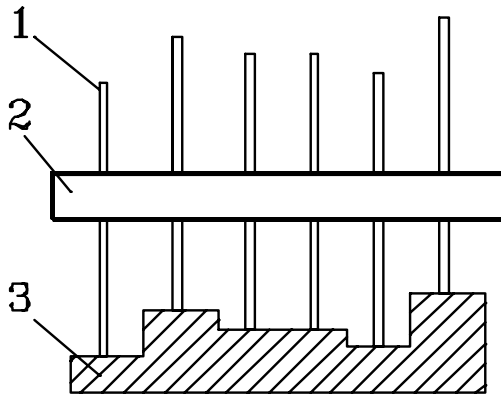
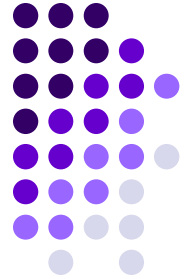


1-obiect de prehensat; 2-membrană elastică; 3-placă transparentă; 4-rază luminoasă

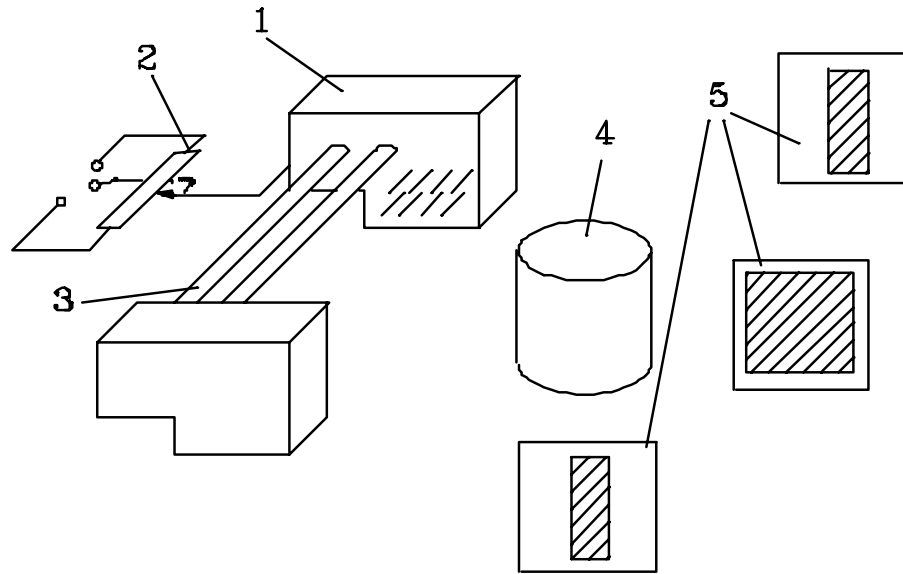


1-membrană;
 2-placă acrilică;
 3-sursă de lumină;
 4 -suport;
 5-deget;
 6-oglină;
 7- ecran

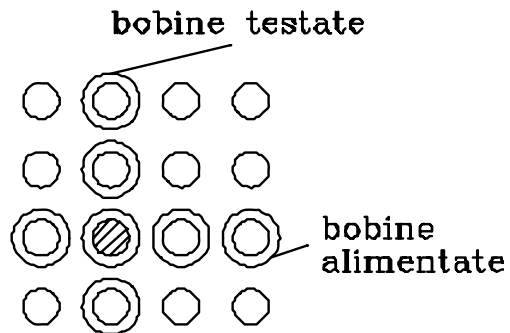
Senzori tactili pentru forme tridimensionale



1-tijă; 2-suport; 3-obiect

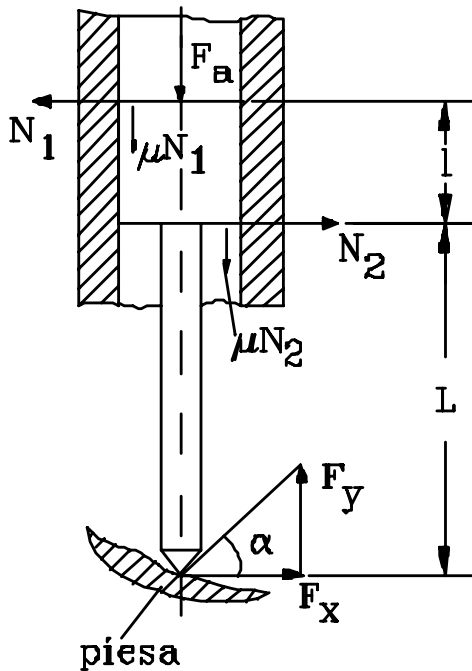
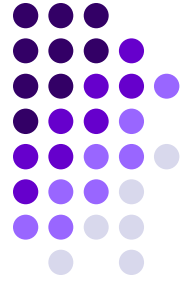
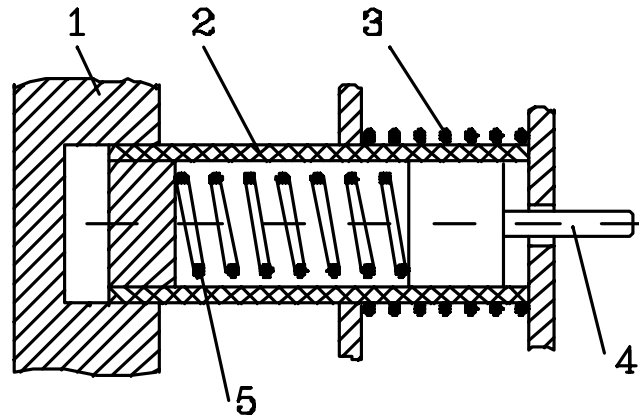


1-bac; 2-traductor de deplasare rezistiv;
3-ghidaj; 4-piesă; 5-plane de relief



Schița principială a unei matrici senzoriale

1-suport; 2-tub; 3-arc;
4-tija;5-arc



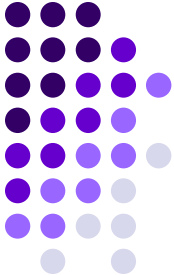
$$N_1 = F_x \cdot \frac{l}{L}$$

$$N_2 = F_x \cdot \left(1 + \frac{l}{L}\right)$$

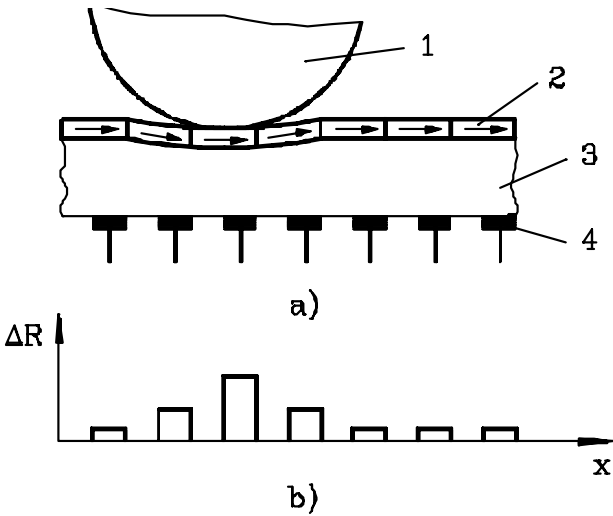
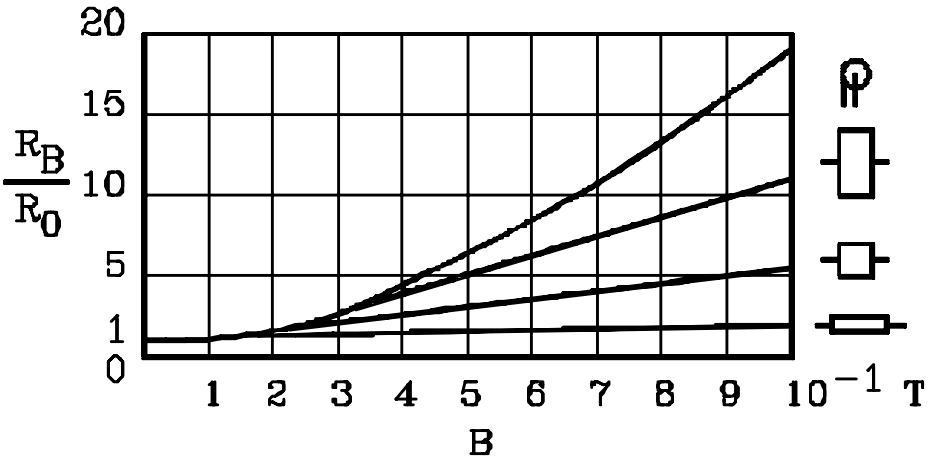
$$F_y \geq \mu \cdot (N_1 + N_2) + F_a$$

$$F_y \geq \frac{F_a}{1 - \mu \cdot \operatorname{tg} \alpha \cdot \left(1 + 2 \frac{l}{L}\right)}$$

Senzori tactili magnetici



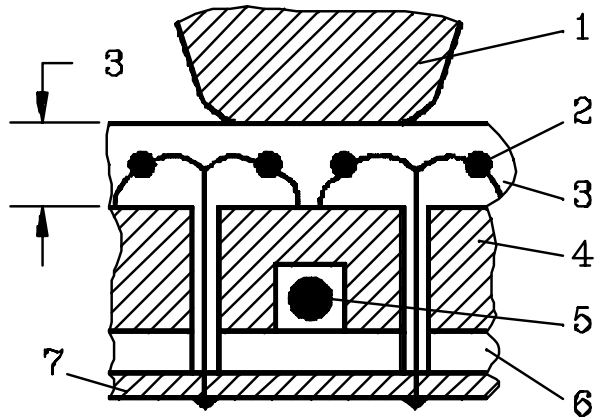
Variația rezistenței în câmp magnetic pentru sonde de diferite forme



- a) soluția principială;
- b) variația rezistenței
- 1-piesă;
- 2-folie magnetică;
- 3-folie din polimer;
- 4-magnetorezistențe

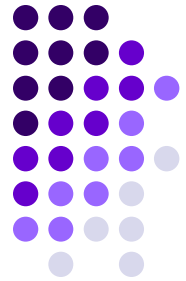
- Senzor tactil:
- a) soluția principială;
 - b) variația rezistenței

Senzori tactili termici



Senzor tactil termic

- 1-obiect; 2-termistor;
- 3-strat de cuplare termică;
- 4-strat intermediar;
- 5-sursă termică;
- 6-strat izolator;
- 7-placă cu circuite

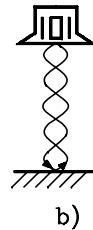
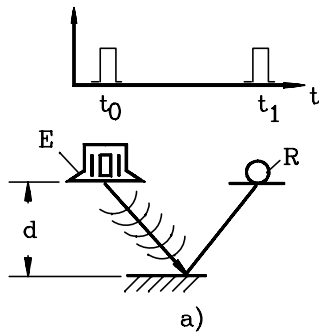


Termistoarele (diametru 1 mm, rezistență 1500 Ω la 250 C) sunt poziționate cu un pas de 3 mm.

Această valoare dă o densitate a punctelor de sensibilitate termică, de același ordin ca și a degetului uman.

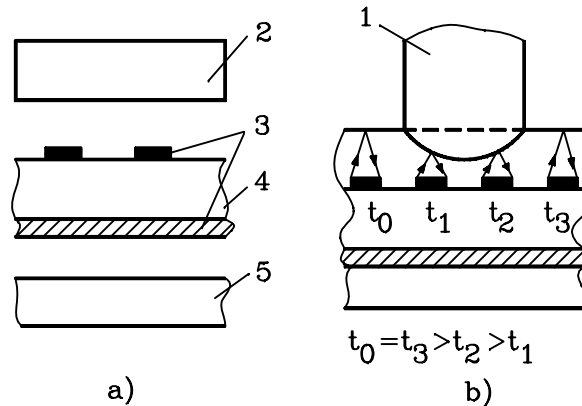
Termistorii au fost aleși pentru dimensiunea lor mică și inerția termică redusă.

Senzori tactili acustici



Variante principale de senzori acustici:

- a) varianta cu emițător și receptor separați
- b) varianta cu emițător și receptor unic

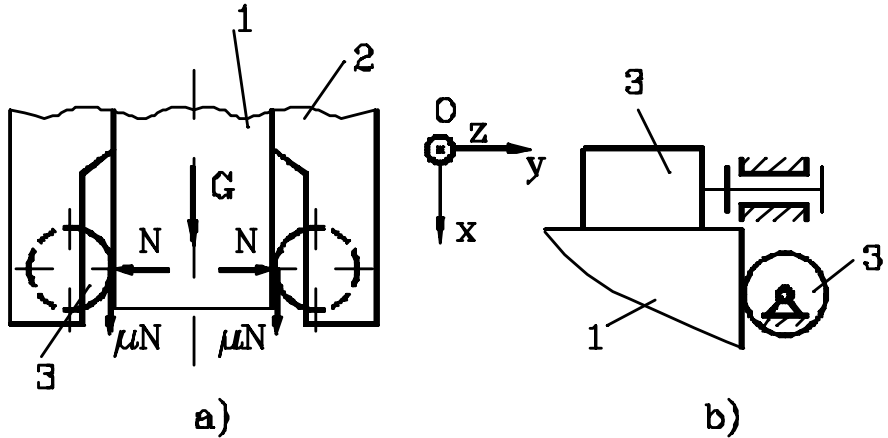
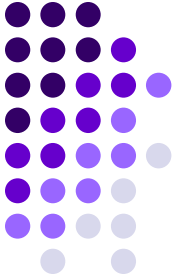


Senzor tactil acustic: a) elementele componente; b) principiul de funcționare (1-obiect; 2-cauciuc siliconic; 3-electrozi; 4-PVDF; 5-strat de bază)

Poliflorura de vinilid (PVDF)

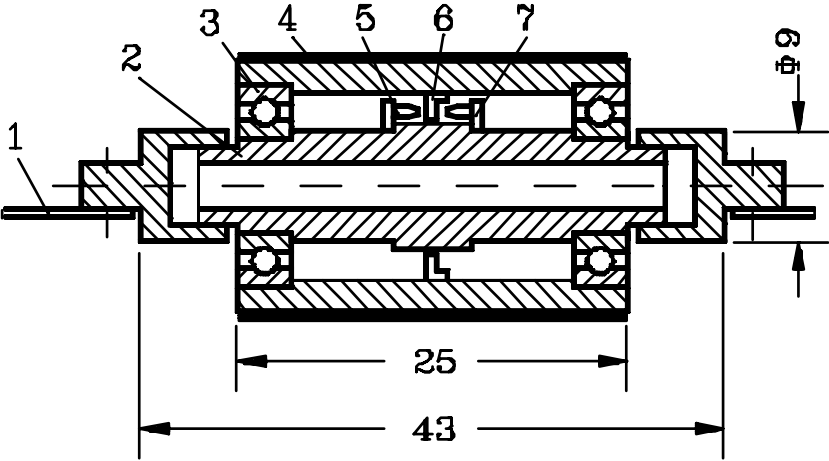
- coeficientul de reflexie pentru o limită de separație cauciuc siliconic / aer este practic -100 %.
- coeficientul de reflexie pentru o zonă de separație cauciuc siliconic / oțel (semnificând contactul bac - piesa metalică) este de 95 %.
- pentru o viteză a undelor sonore de $c = 1000$ m/s prin cauciucul siliconic, timpul necesar unui impuls sonor de a traversa și a se întoarce pe distanța de 3 mm este de 6 μ s. În cazul comprimării stratului de cauciuc siliconic, cu până la 80 % din grosimea inițială (aprox. 0.6 mm), timpul necesar impulsului sonor este de 24 ns.

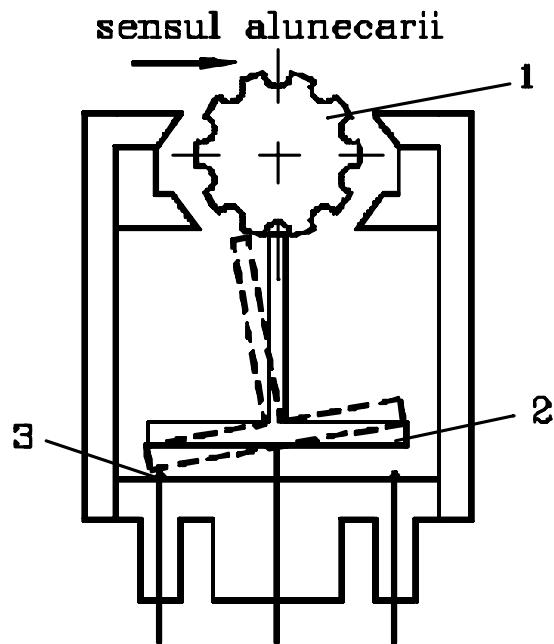
Senzori tactili de alunecare



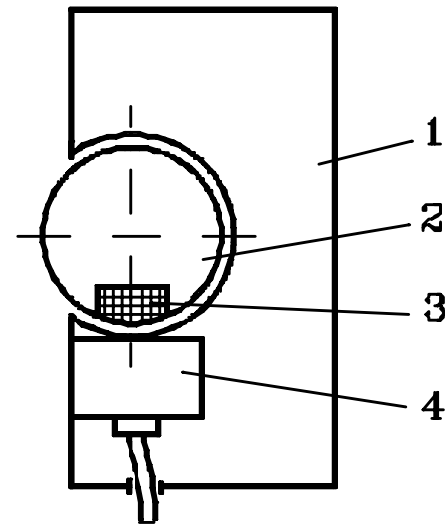
a) detectarea alunecării; b) -detectarea sensului alunecării

1-piesă; 2-bac; 3-rolă





- 1 – bila cu concavitati
- 2 - pârghie elastică
- 3 – contacte închise



- 1 - bac
- 2 – rola din cauciuc
- 3 – magnet
- 4 - bobina

